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TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

FOR PROMOTING USEFUL KNOWLEDGE

PUBLISHED BY THE SOCIETY

VAN Compton

MUSEUM OF COMPARATIVE ZOOLOGY HARVARD

TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA,

FOR PROMOTING USEFUL KNOWLEDGE.

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1. The Transactions shall be published in numbers, at short intervals, under the direction of the Committee of Publication.

2. Every communication to the Society, which may be considered as intended for a place in the Transactions, shall immediately be referred to a committee to consider and report thereon.

3. If the committee shall report in favour of publishing the communication, they shall make such corrections therein, as they may judge necessary to fit it for the Press; or if they shall judge the publication of an abstract or extracts from the paper to be most eligible, they shall accompany their report with such abstracts or extracts. But if the author do not approve of the corrections, abstracts, or extracts, reported by the committee, he shall be at liberty to withdraw his paper.

4. The order in which papers are read before the Society shall determine their places in the Transactions, priority of date giving priority of location.

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FOR THE YEAR 1846.

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CONTENTS.

Page

Laws of the Society relating to the Transactions, ... iii
Officers of the Society for the Year 1846, ... iv
List of the Members of the Society elected since the Publication of the Eighth Volume, . . . v
Obituary Notice, ... vi

ARTICLE I.

Continuation of Mr. Lea's Paper on Fresh Water and Land Shells, ... 1

ARTICLE II.

Account of a Trigonometrical Survey of Massachusetts, by Simeon Borden, Esq., with a Comparison of its Results with those obtained from Astronomical Observations, by Robert Treat Paine, Esq., communicated by Mr. Borden, ... 33

ARTICLE III.

Observations on Egyptian Ethnography, derived from Anatomy, History, and the Monuments. By Samuel George Morton, M.D., ... 93

ARTICLE IV.

On Two Storms which were experienced throughout the United States, in the Month of February, 1842. By Elias Loomis, ... 161

ARTICLE V.

On the Conversion of Benzoic into Hippuric Acid. By James C. Booth and Martin H. Boyè, . . . 185

ARTICLE VI.

Account of the Observatory and Instruments of the United States Military Academy at West Point; with Observations on the Comet of 1843. By William H. C. Bartlett, ... 191

ARTICLE VII.

Memoir of the Character and Prospects of the Copper Region of Gibara, and a Sketch of the Geology of the north-east part of the Island of Cuba. By Richard C. Taylor, ... 204

ARTICLE VIII.

Notice of Fossil Arborescent Ferns, of the Family Sigillaria, and other Coal Plants, exhibited in the Roof and Floor of a Coal Seam, in Dauphin County, Pennsylvania. By Richard C. Taylor, ... 219

Page

ARTICLE IX.

Description of Some New Fossil Shells from the Tertiary of Petersburg, Virginia. By Henry C. Lea, . 229

ARTICLE X.

Description of New Fresh Water and Land Shells. By Isaac Lea, ... 275

ARTICLE XI.

Observations made in the Years 1838, '39, '40, '41, '42, and '43, to determine the Magnetical Dip and the Intensity of Magnetical Force, in several parts of the United States. By John Locke, M. D., Professor of Chemistry and Pharmacy in the Medical College of Ohio, ... 283

ARTICLE XII.

Observations of the Magnetic Dip, made at several positions, chiefly on the south-western and north-eastern frontiers of the United States, and of the Magnetic Declination at two positions on the River Sabine; in 1840. By Major James D. Graham, of the United States' Corps of Topographical Engineers, ... 329

Donations to the Library and Cabinet, ... 381

TRANSACTIONS

OF

THE AMERICAN PHILOSOPHICAL SOCIETY.

ARTICLE I.

Continuation of Mr. Lea's Paper on Fresh Water and Land Shells. Read February 19, 1841.

HELIX & CAROCOLLA. (LAMARCK.)

THE genus *Helix* is widely scattered over the soil of the United States, and the same species have in many instances a very wide geographical range. Climatal influence is very evident in many species.—In some localities they are more inflated and larger; in others more depressed, even becoming *carinate* like the genus *Carocolla.* The uncertainty of this *carinate* character has induced me to hesitate in the admittance of the genus *Carocolla,* but the number of *Helices* is so great that a strong inducement is presented to preserve it for the present.

The *Helices* of the United States are nearly all of a dull horn colour, and in this respect not very attractive. Most of the species are, however, furnished with apertures differing much from each other, and presenting the most interesting characters as regards teeth, &c. Mr. Say has described thirty-nine species, and seventeen have been proposed by myself and other naturalists. To that number I propose now to add a single species, as well as one to the genus *Carocolla.*

HELIX TENNESSEENSIS.*

Testâ suprà plano-convexâ, subtus convexâ, luteâ, obliquè striatâ, umbilicatâ; spirâ brevi; suturis subimpressis; anfractibus quinis, subconvexis; aperturâ lunatâ; labro intus incrassato.

Shell above plano-convex, beneath convex, yellow, obliquely striated, umbilicated; spire short; sutures somewhat impressed; whorls five, somewhat convex; aperture lunate; lip thickened within.

Hab. Cumberland Mountains, Tennessee. S. M. Edgar. My Cabinet, and Cabinet of Mr. Edgar. Diam. .45, Length .32 of an inch.

Remarks.—A species very nearly allied to *H. limbata,* Drap. It differs in having a wider umbilicus, a less expanded aperture, and having an indistinct brownish line on the periphery, the *limbata* having a white and very distinct one. The striæ cover the whole

* It is regretted that the figures to illustrate the species of Mr. Lea's paper cannot now appear. It is hoped that they may be hereafter furnished.

 publ. in 1844.

surface of the shell, but are more distinct on the superior part. The thickening of the line within the edge of the lip gives a white band on the outside.

Carocolla Edgariana.

Testâ suprà subplanâ, subtus convexâ, rufo-fuscâ, enormiter striatâ, imperforatâ; spirâ brevi; suturis vix impressis; anfractibus quinis, planulatis; aperturâ angustissimâ; columellâ dentem unicum longum et laminatum habente; labro incrassato, in medio incisso.

Shell nearly flat above, beneath convex, reddish brown, irregularly striate, imperforate; spire short; sutures scarcely impressed; whorls five, flattened; aperture very narrow; columella furnished with a long lamellar tooth; lip thickened, in the middle notched.

Hab. Cumberland Mountains, Tennessee. S. M. Edgar. My Cabinet and Cabinets of Mr. Edgar and Dr. Troost. Diam. .40, Length .20 of an inch.

Remarks.—Among a number of *Helices* taken by Mr. Edgar were three specimens of this species, which do not seem to have been before observed. The carina is sharp. The form of the aperture that of *H. hirsuta*, (Say,) except that the superior and thick part of the lip joins the tooth of the columella. On the surface of the shell there is no hirsute character. Several specimens of the *hirsuta* accompanied them, all of which presented their usual subglobose character. It differs from *C. spinosa*, (nobis,) in being smaller, less flattened, and being without the cilia.

Bulimus Jayanus.

Testâ ovato-conicâ, crassâ, suprà albidâ, subtus castaneâ, perforatâ; anfractibus senis, subconvexis; aperturâ ellipticâ; labro reflexo, albo, margine lineato; columellâ albâ, lævi.

Shell ovately conical, thick, whitish above, chestnut colour below, perforate; whorls six, somewhat convex; aperture elliptical; lip reflected, white, margin lineate; columella white, smooth.

Hab. Java? My Cabinet and Cabinet of Dr. Jay. Diam. .1, Length, 1 .9 of an inch.

Remarks.—This species was purchased of a dealer who informed me that it came from Java. It is remarkable for the distinct division of the colour on the middle of the lower whorl, the superior part being whitish with distinct longitudinal brown striæ and spots below the sutures, which are very small. The perforation is very small, and around it the colour is lighter. The chestnut colour of the lower part is visible in the interior, and on the white lip forms a rather sharp angle. The brown line on the margin of the lip is very distinct. The apex is black, the aperture is nearly one-half the length of the shell.

Achatina turbinata.

Testâ turbinatâ, fuscâ, suprà obliquo-fasciatâ et maculatâ, striis minutis decussantibus; suturis impressis; anfractibus octonis, convexis, infrà suturas impressis; aperturâ parvâ, ovatâ; columellâ incurvâ.

Shell turbinate, brownish, above obliquely banded and spotted, with minute decussate striæ; sutures impressed; whorls eight, convex, impressed below the sutures; aperture small, ovate; columella incurved.

Hab. Liberia. Dr. Blanding. My Cabinet and Cabinet of Dr. Blanding. Diam. 1 .4, Length 2 .7 inches.

Remarks.—Among many shells procured from Liberia by Dr. Blanding were a few specimens of this *Achatina* which I believe has not been described. It has some resemblance to *A. flammata*, Cailliaud, but is a larger species. Those sent to me by that traveller, from Sennar, being very much exserted. The *flammata* from the south of Africa is

shorter than that from Nubia, but it is not so turbinate as this species, nor do they agree in the form of their apertures nor in the markings. On the lower whorl the *turbinata* is brown. The superior whorls are obliquely marked with brown bands, which are broken up into spots on the penultimate whorl, and become darker. In the form of the mouth it approaches very closely to the genus *Bulimus*.

Achatina striata.

Testâ subcylindraceâ, corneâ, tenui, longitudinaliter elegantissimèque striatâ; suturis impressis; anfractibus octonis, subconvexis; aperturâ parvâ, ellipticâ; columellâ incurvatâ.

Shell somewhat cylindrical, horn colour, thin, longitudinally and beautifully striate; sutures impressed; whorls eight, rather convex; aperture small, elliptical; columella incurved.

Hab. Liberia. Dr. Blanding. My Cabinet and Cabinet of Dr. Blanding. Diam. .12, Length .38 of an inch.

Remarks.—This is a beautiful little species, rather larger than the *folliculus*, Lam. In form it resembles *Bulimus octoneus*, Rang. (*Achatina*,) but is not quite so large. Its minute and close ribs distinguish it at once, as the *octoneus* is perfectly smooth. The aperture is about one-fourth the length of the shell, and the striæ do not extend below the middle part of the lower whorl.

GENUS SUCCINEA. (Draparnaud.)

Eight species of *Succinea* have been described as inhabiting the United States. I now propose to add nine to that number, besides three from the West Indies and East Indies.

Succinea gracilis.

Testâ longo-ovatâ, obliquâ, exsertâ, subdiaphanâ, striatâ, pallido-luteâ; spirâ elevatâ; suturis impressis; anfractibus subconvexis; aperturâ longo-ovatâ.

Shell long-ovate, oblique, exserted, subdiaphanous, striate, pale yellow; spire elevated; sutures impressed; whorls subconvex; aperture long-ovate.

Hab. Java? My Cabinet. Diam. .32, Length .42 of an inch.

Remarks.—I procured a single specimen of this graceful and delicate species in New York of a dealer some years since. He informed me that it came from the collection of Mr. Shillaber, which was brought from Batavia. In form it resembles *S. Nuttalliana* herein described, but it is a much more exserted species and larger. The whorls below the sutures are impressed. The striæ are larger and more distant near to the aperture. A small portion only of the epidermis remains, and that is dark. The point of the spire is fractured, and therefore the number of the whorls is not mentioned. I suppose, when perfect there will be found three. The want of the usual transparency may be occasioned by the specimen not being fresh.

Succinea Wardiana.

Testâ obliquo-ovatâ, subnitidâ, diaphanâ, obsoletè striatâ, luteâ; spirâ breviusculâ; suturis subimpressis; anfractibus ternis, convexis; aperturâ subrotundâ.

Shell obliquely ovate, somewhat shining, diaphanous, obsoletely striate, yellowish; spire rather short; sutures rather impressed; whorls three, convex; aperture nearly round.

Hab. Ohio. Dr. Ward. My Cabinet and Cabinet of P. H. Nicklin. Diam. .20, Length .32 of an inch.

Remarks.—This species was sent to me by the late Dr. Ward from Roscoe, in the northern part of Ohio, and I presume came from the vicinity of that place. It is allied to *S. vermeta*, (Say,) but has a less exserted spire and is not quite so oblique. It is also a smaller species. The aperture is about two-thirds the length of the shell.

Succinea Totteniana.

Testâ obliquo-ovatâ, subnitidâ, subdiaphanâ, obsoletè striatâ, corneâ; spirâ brevi; suturis impressis; anfractibus ternis, convexis; aperturâ ellipticâ.

Shell obliquely ovate, somewhat shining, rather transparent, obsoletely striate, horn colour; spire short; sutures impressed; whorls three, convex; aperture elliptical.

Hab. Newport, Rhode Island. Col. Totten, United States Army. My Cabinet, and Cabinets of Col. Totten, and P. H. Nicklin. Diam. .30, Length .48 of an inch.

Remarks.—Many years since Col. Totten sent me this species. Never having been able to identify it with any described species, I now propose to name it after him. It is rather an inflated species, but not so much so as the *obliqua*, (Say,) nor is it so large. It resembles the *ovalis*, (Say,) but is rather smaller, more oblique and less inflated. The aperture is rather more than two-thirds the length of the shell, and the apex is very small, somewhat mamillate. The epidermis is rather dark. The substance of the shell is slightly iridescent, giving it an opalescent appearance, and this is slightly observed through the epidermis.

Succinea Nuttalliana.

Testâ longo-ovatâ, obliquâ, subnitidâ, diaphanâ, striatâ, pallido-luteâ; spirâ subelevatâ; suturis impressis; anfractibus ternis, subconvexis; aperturâ longo-ovatâ.

Shell long-ovate, oblique, transparent, striate, pale yellow; spire rather elevated; sutures impressed; whorls three, somewhat convex; aperture long-ovate.

Hab. Oregon. Prof. Nuttall. My Cabinet and Cabinets of Prof. Nuttall, and Dr. Jay. Diameter .25, Length .50 of an inch.

Remarks.—A very oblique, slender and graceful species, allied to *retusa* nobis, but smaller, less elongated, and not having the inferior part or base quite so retuse. The aperture is about three-fourths the length of the shell.

Succinea aurea.

Testâ obliquo-ovatâ, nitidâ, diaphanâ, lævi, aureâ; spirâ subelevatâ; suturis impressis; anfractibus ternis, convexis; aperturâ ovatâ.

Shell obliquely ovate, shining, transparent, smooth, golden; spire rather elevated; sutures impressed; whorls three, convex; aperture ovate.

Hab. Springfield, Ohio. T. G. Lea. My Cabinet and Cabinets of T. G. Lea, and P. H. Nicklin. Diam. .20, Length .32 of an inch.

Remarks.—This is a beautiful little species, remarkable for its fine surface and bright golden colour. In form it is nearly allied to *vermeta*, (Say.) In colour it has some resemblance to a species sent to me by M. D'Orbigny, from Paris, under the name of *putris*, Lin., and obtained by him in Colombia. His shell is quite different from the *putris* of Europe, and I propose the name of the distinguished traveller for it; if I am correct, *Succinea Dorbigniana*. The aperture of the *aurea* is about three-fifths the length of the shell.

Succinea Candèana.

Testâ obliquo-ovatâ, subnitidâ, obsoletè varicosâ, diaphanâ, roseâ; spirâ brevi; suturis subimpressis; anfractibus ternis, inflatis; aperturâ lato-ovatâ.

Shell obliquely ovate, somewhat shining, obsoletely varicose, diaphanous, rose colour; spire short; sutures impressed; whorls three, inflated; aperture wide-ovate.

Hab. Martinique. Lieut. Candè. My Cabinet and Cabinet of M. Candè, Paris. Diam. .58, Length .85 of an inch.

Remarks.—Lieut. Candè, of the French navy, was kind enough, a few years since, to give me, among many interesting shells, collected in the Island of Martinique, several specimens of this *Succinea*, which I name after him. I am not aware that it has elsewhere been noticed. In form and size it resembles *S. obliqua*, (Say.) It is, however, larger, has the sutures less impressed, of a redder colour, and in its varicose markings entirely differs. It has some resemblance to that species figured by Ferussac, pl. II. A. fig. 7, but it is more inflated, and the spire is much more obtuse.

Succinea fulgens.

Testâ obliquo-ovatâ, fulgens, diaphanâ, striatâ, aureâ; spirâ subelevatâ; suturis impressis; anfractibus ternis, convexis; aperturâ lato-ovatâ.

Shell obliquely ovate, brilliant, diaphanous, striate, golden colour; spire rather elevated; sutures impressed; whorls three, convex; aperture wide-ovate.

Hab. Cuba. M. Poey. My Cabinet. Diam. .30, Length .45 of an inch.

Remarks.—Among other land shells received some years since from Mr. Poey, who had under his charge the Botanic Garden of Havana, I received a single specimen of *Succinea* which does not appear to me to have been described. In form it somewhat resembles the *ovalis*, (Say,) but differs in size and colour. In its brilliant colour it is allied to *S. aurea* herein described. It is, however, less brilliant, more inflated, and quite double the size. The aperture is about two-thirds the length of the shell, and the apex takes a reddish hue.

Succinea Oregonensis.

Testâ obliquâ, tenui, rugoso-striatâ, rufâ, subdiaphanâ; spirâ exsertâ; suturis valdè impressis; anfractibus ternis, inflatis; aperturâ magnâ, lato-ovatâ.

Shell oblique, thin, rugosely striate, reddish, subdiaphanous; spire exserted; sutures much impressed; whorls three, inflated; aperture large, wide-ovate.

Hab. Oregon. Prof. Nuttall. My Cabinet, and Cabinets of Prof. Nuttall, and Dr. Jay. Diam. .15, Length .30 of an inch.

Remarks.—A single specimen only of this small species was given to me by Mr. Nuttall. It nearly answers to Mr. Say's description of *S. avara*, but differs in size, colour and form from that usually received as his species. The spire is elevated for a *Succinea*, and curls somewhat like a worm. The aperture is a good deal rounded, and is about two-thirds the length of the shell.

Succinea inflata.

Testâ subrotundâ, inflatâ, tenui, lacteâ; spirâ brevi; suturis subimpressis; anfractibus ternis, rotundatis; aperturâ lato-ovatâ.

Shell subrotund, inflated, thin, milk-white; spire short; sutures impressed; whorls three, rounded; aperture wide-ovate.

Hab. South Carolina. Prof. Ravenel. My Cabinet, and Cabinet of Prof. Ravenel. Diam. .30, Length .45 of an inch.

Remarks.—Many years since Prof. Ravenel sent me several specimens of this species under the name of *S. campestris*, (Say.) It does not, however, answer entirely to Say's description, and it certainly is not the same species with those placed in the Philadelphia Museum under that name by him. It is a more inflated species. It is quite white, with a few semi-transparent longitudinal lines. The aperture is about three-fourths the length of the shell.

PLANORBIS. (LAMARCK.)

Seventeen species of the genus *Planorbis* have been described as inhabiting the waters of the United States, and I now propose to add three to that number. Lamarck described twelve, of which eight inhabit Europe.

PLANORBIS REGULARIS.

Testâ subglobosâ, supernè subplanâ, subtus angusto-umbilicatâ, pellucidâ, pallido-luteâ, obsoletè striatâ; anfractibus ternis, supernè carinatis; labro acuto, marginato, intus incrassato; aperturâ ovatâ.

Shell subglobose, above nearly flat, beneath narrow umbilicate, pellucid, pale yellow, obsoletely striate; whorls three, above carinate; lip acute, margined, within thickened; aperture ovate.

Hab. United States. My Cabinet and Cabinet of P. H. Nicklin. Diam. .30, Length .20 of an inch.

Remarks.—I have unfortunately mislaid the label which accompanied the shells from which the above descriptions were made. My impression is that they came from one of the Western States. All the specimens before me are very much alike in size and form, being exceedingly regular. The striæ are more perceptible around the umbilicus and on the spire. On the side they are so much obliterated as to permit the whorl to present a shining appearance. The carina is very sharp and well defined. It has very much the appearance of a young *trivolvis*, (Say,) and may possibly be only a variety of that species.

PLANORBIS BUCHANENSIS.

Testâ sublenticulari, supernè subconvexâ, ad periphæriam carinatâ, subtus angusto-umbilicatâ, vel corneâ vel subfuscâ, lævi; anfractibus ternis; labro acuto; aperturâ rotundâ.

Shell sublenticular, above subconvex, carinate at the periphery, beneath narrow umbilicate, horn-colour or brownish, smooth; whorls three; lip sharp; aperture rounded.

Hab. Near Cincinnati, Ohio. R. Buchanan. My Cabinet, and Cabinets of T. G. Lea, and R. Buchanan. Diam. .12, Length .08 of an inch.

Remarks.—Several specimens of this species were sent to me several years since by my brother T. G. Lea, who informed me that they were first observed by Mr. Buchanan, after whom I name it. This species is very nearly allied to *P. lens*,* nobis, but it may at once be distinguished by its round aperture, which is somewhat spread out. The aperture of the *lens*, (now *lenticularis*,) is *triangular*, and the size of the shell rather larger.

PLANORBIS BELLUS.

Testâ orbiculari, supernè plano-concavâ, subtus lato umbilicatâ, virido-luteâ, crebrissimè et elegantissimè striatâ; anfractibus quaternis, supernè carinatis, subtus subcarinatis; labro acuto; aperturâ parvâ, subrotundâ, intus rufo-fuscâ.

Shell orbicular, above regularly concave, beneath widely umbilicate, greenish yellow, closely and beautifully striate; whorls four, carinate above, subcarinate below; lip sharp; aperture small, within reddish brown.

Hab. Tennessee. Dr. Troost. My Cabinet, and Cabinet of Dr. Troost. Diam. .40, Length .22 of an inch.

* This name being preoccupied, I propose to change it to *lenticularis*.

Remarks.—A single specimen only of this species was received from Dr. Troost. Like the *P. corpulentus*, (Say,) it is covered with striæ, but in the *bellus* they are much closer and more regular. It is a much less inflated shell, and more regular in its form.

PHYSA. (LAMARCK.)

The genus *Physa*, established, as some authors say, for the reversed species of *Lymnæa*, is abundant in the fresh waters of our country. There have been twelve species heretofore described as inhabiting the United States, and I now propose to add three more to the number.

As to the propriety of the separation from *Lymnæa*, I have no doubt. To those who have been familiar with many species of the two genera, their distinctive characters will, I think, be perfectly apparent. Lamarck described only four species.

PHYSA HILDRETHIANA.

Testâ ellipticâ, subcompressâ, longâ, subpellucidâ; spirâ obtuso-elevatâ; anfractibus quinis; labro marginato; aperturâ longâ, compressâ.

Shell elliptical, somewhat compressed, long, somewhat pellucid; spire obtusely elevated; whorls five; lip margined; aperture long, compressed.

Hab. A lake in Illinois. Dr. Hildreth. My Cabinet, and Cabinet of Dr. Hildreth. Diam .40, Length .75 of an inch.

Remarks.—This species is among the largest, and is perhaps the most remarkable *Physa* yet observed in this country. The aperture is little more than half the length of the shell. The apex is very obtuse, and the whole shell is somewhat cylindrical. A single specimen was brought by Mr. Nicklin from Dr. Hildreth, and I name it after him, as he seems first to have observed it.

PHYSA INFLATA.

Testâ inflatâ, tenebrosâ, subpellucidâ; spirâ subelevatâ, acuto-conicâ; anfractibus quinis; labro marginato inflato; aperturâ latâ.

Shell inflated, dark, somewhat pellucid; spire somewhat elevated, acutely conical; whorls five; outer lip margined and inflated; aperture wide.

Hab. Virginia, between the Salt Sulphur, and the Sweet Springs. P. H. Nicklin. My Cabinet and Cabinet of Mr. Nicklin. Diam. .48, Length .65 of an inch.

Remarks.—Two specimens were taken by Mr. Nicklin in a small stream which crosses the road in a gap in the main chain of the Alleghany Mountain between the Salt Sulphur and the Sweet Springs in Virginia. The gap is nearly level for several miles, and some of the streams run to the West and some to the East. This species seems to me to differ from any with which I am acquainted. It is perhaps most nearly allied to *P. heterostropha*, (Say,) but has a shorter aperture and is more inflated.

PHYSA TROOSTIANA.

Testâ ellipticâ, subcrassâ, luteo-fuscâ, lævi; spirâ obtusâ; suturis subimpressis; anfractibus quinis, subconvexis; labro marginato, intus incrassato; aperturâ parvâ, ovatâ, contractâ.

Shell elliptical, rather thick, yellow-brown, smooth; spire obtuse; sutures slightly impressed; whorls five, slightly convex; lip margined, thickened within; aperture small, ovate, contracted.

Hab. Near Nashville, Tennessee. Dr. Troost. My Cabinet and Cabinet of Dr. Troost. Diam. .25, Length .45 of an inch.

Remarks.—This is a short, obtuse species about the size of *P. aurea*, (nobis.) The substance of the shell is very thick for the genus, and it is much more thickened within the margin than any species I have observed. The line along the margin of the lip is of a reddish brown. The indentation of the columella is lower than usual. The aperture is about two-thirds the length of the shell.

GENUS LYMNÆA. (LAMARCK.)

The genus *Lymnæa* seems to be widely distributed round the globe. Lamarck describes seven species as indigenous to France. We have had twenty-seven species described by Mr. Say, and other American zoologists, and to them I now propose to add sixteen from our own country, including several brought by Mr. Nuttall from Oregon, besides one taken by this traveller from Oahu.

In the enumeration above, I include Mr. Say's *L. appressa*, although my conviction has been for a long time that it is only the analogue of *stagnalis* of Europe. I have taken it on the St. Lawrence, and my cabinet is also possessed of American specimens from Vermont, Ohio, and Oregon. Its geographical distribution is probably wider than that of any other species of *Lymnæa*.

LYMNÆA PHILADELPHICA.

Testâ ovato-conicâ, tenui, striatâ, nitidâ, diaphanâ, subaureâ, imperforatâ; spirâ subelevatâ; suturis valdè impressis; anfractibus quinis, convexis; aperturâ angusto-ellipticâ.

Shell ovately conical, thin, striated, shining, diaphanous, rather golden, imperforate; spire rather elevated; sutures much impressed; whorls five, convex; aperture narrow-elliptical.

Hab. River Schuylkill, near Philadelphia. My Cabinet, and Cabinets of P. H. Nicklin, and Dr. Griffith. Diam. .20, Length .48 of an inch.

Remarks.—This species is about the size of, and is allied to *plica* and *Griffithiana*, herein described, and to *modicella*, (Say.) It has a more elongated aperture than *Griffithiana*, has a smaller fold than *plica*, and is higher in the spire than *modicella*. The aperture is about half the length of the shell. I procured many specimens west of Philadelphia. Dr. Griffith informs me that he found them common south of the city.

LYMNÆA GRIFFITHIANA.

Testâ ovato-conicâ, tenui, substriatâ, nitidâ, subdiaphanâ, luteo-corneâ, perforatâ; spirâ breviusculâ; suturis impressis; anfractibus quinis, convexis; aperturâ ellipticâ.

Shell ovately conical, thin, substriate, shining, somewhat diaphanous, yellowish horn-colour, perforate; spire rather short; sutures impressed; whorls five, convex; aperture elliptical.

Hab. Charlotte Lake, Columbia County, New York. Dr. Griffith. My Cabinet, and Cabinets of Dr. Griffith, and Philadelphia Museum. Diam. .20, Length .30 of an inch.

Remarks.—Rather a small species, differing from most in the form of the mouth, which is nearly a perfect ellipse. In a perfect specimen before me the aperture within the margin of the lip is thickened by a raised line. The aperture is not quite one-half the length of the shell. I name it after R. E. Griffith, M. D., who seems to be the only person who has observed it.

Lymnæa Nuttalliana.

Testâ ovato-conicâ, subtenui, striatâ, subdiaphanâ, pallido-fuscâ, imperforatâ; spirâ breviusculâ; apice rufâ; suturis impressis; anfractibus senis, convexis; aperturâ ovatâ, inflatâ, intus fasciatâ.

Shell ovately conical, rather thin, striate, subdiaphanous, pale brown, imperforate; spire rather short; apex red; sutures impressed; whorls six, convex; aperture ovate, inflated, banded within.

Hab. Oregon. Prof. Nuttall. My Cabinet and Cabinets of Prof. Nuttall, and Dr. Jay. Diam. .50, Length .95 of an inch.

Remarks.—A fine, rather robust species, resembling *L. elodes*, (Say,) but shorter and more inflated and having a larger and more curved fold. The aperture is rather more than one-half the length of the shell, and is retuse at the lower part. Under the lens may be observed very minute revolving striæ. The band within the aperture is removed from the edge of the lip, and is broad and brown. The lip is not reflexed.

Lymnæa bulimoides.

Testâ ovato-conicâ, subtenui, lævi, nitidâ, diaphanâ, fusco-luteâ, minutè perforatâ; spirâ breviusculâ; suturis parvis; anfractibus quinis, subconvexis; aperturâ ovatâ.

Shell ovately conical, rather thin, smooth, shining, diaphanous, brownish yellow, slightly perforate; spire rather short; sutures small; whorls five, slightly convex; aperture ovate.

Hab. Oregon, Prof. Nuttall. My Cabinet, and Cabinet of Prof. Nuttall. Diam. .22, Length .38 of an inch.

Remarks.—Among the shells taken by Prof. Nuttall during his journey over the Rocky Mountains, was this small species, the aperture of which is formed very much like a *Bulimus*. The deposite of the columella is wide, and nearly covers the perforation, which consequently is very small. The aperture is more than half the length of the shell, and the fold obsolete. Several of the specimens, although the substance of the shell is thin, have the apex eroded, some of the superior whorls being entirely gone. I have not observed this to be the case in any other *Lymnæa*.

Lymnæa exigua.

Testâ subfusiformi, tenui, striatâ, subdiaphanâ, pallido-luteâ, perforatâ; spirâ breviusculâ; suturis impressis; anfractibus quinis, subconvexis; aperturâ ellipticâ.

Shell subfusiform, thin, striated, subdiaphanous, pale yellow, perforate; spire rather short; sutures impressed; whorls five, rather convex; aperture elliptical.

Hab. Tennessee. Dr. Troost. My Cabinet and Cabinet of Dr. Troost. Diam. .15, Length .35 of an inch.

Remarks.—This is a small species about the size of *L. plica*, herein described, and in outline resembling it. It differs, however, altogether in the columella, which is nearly straight, and the folds scarcely observable. The aperture is about one-half the length of the shell, and contracted at the lower part.

Lymnæa planulata.

Testâ ovato-conicâ, tenui, lævi, subdiaphanâ, fuscâ, perforatâ; spirâ breviusculâ; suturis impressis; anfractibus quinis, convexis; aperturâ parvâ, ovatâ.

Shell ovately conical, thin, smooth, subdiaphanous, brown, perforate; spire rather short; sutures impressed; whorls five, convex; aperture small, ovate.

Hab. White Sulphur Springs, Virginia. P. H. Nicklin. My Cabinet and Cabinet of P. H. Nicklin. Diam. .15, Length .35 of an inch.

Remarks.—Several specimens of this small species are before me, one of them considerably larger than the other, and possessing one more whorl. The whorls are inflated, but flattened in the middle. This gives a roundness to their superior part. The perforation is small, and the fold scarcely observable. The aperture is less than half the length of the shell, and contracted.

Lymnæa fusiformis.

Testâ fusiformi, subcrassâ, crebrè striatâ, pallido-luteâ, imperforatâ; spirâ breviusculâ; suturis leviter impressis; anfractibus senis, planulatis; aperturâ angusto-ellipticâ.

Shell fusiform, rather thick, closely striate, pale yellow, imperforate; spire rather short; sutures slightly impressed; whorls six, flattened; aperture narrow-elliptical.

Hab. Niagara river, Lewistown, New York. Tobias Wagner. My Cabinet, and Cabinets of P. H. Nicklin, and Tobias Wagner. Diam. .35, Length .60 of an inch.

Remarks.—Among a number of interesting shells collected by Mr. T. Wagner, during a long journey in the interior of our country, were several specimens of this species, which has not been, I believe, before noticed. It is found with and is somewhat allied to *L. decidiosa*, (Say.) It differs in being more fusiform, having a larger aperture and flatter whorls, and in being imperforate. It is about the size of, and resembles *L. casta*, herein described. It differs in being less elevated in the spire, in the whorls being more flattened, in having a distinct and curved fold, and in being imperforate. The aperture is nearly two-thirds the length of the shell. The last two whorls are disposed to be wrinkled.

Lymnæa rustica.

Testâ subfusiformi, tenui, imperforatâ; spirâ subelevatâ; suturis impressis; anfractibus quinis, subconvexis; aperturâ angusto-ellipticâ.

Shell subfusiform, thin, imperforate; spire rather elevated; sutures impressed; whorls five, rather convex; aperture narrow elliptical.

Hab. Poland, Ohio. Dr. Kirtland. My Cabinet, and Cabinet of Dr. Kirtland. Diam. .15, Length .35 of an inch.

Remarks.—A single specimen only of this was received with some other species. It is a small and rather slender species, with a regular tapering spire and an aperture about half the length of the shell. The whole shell is covered over with a red coating of the oxide of iron, giving it a rough aspect.

Lymnæa plica.

Testâ turritâ, subtenui, luteâ, striatâ, imperforatâ; spirâ subelevatâ; suturis impressis; anfractibus quinis, convexis; aperturâ parvâ, ellipticâ.

Shell turrited, rather thin, yellow, striate, imperforate; spire rather elevated; sutures impressed; whorls five, convex; aperture small, elliptical.

Hab. Tennessee. Dr. Troost. My Cabinet, and Cabinet of Dr. Troost. Diam. .18, Length .38 of an inch.

Remarks.—A small species, with a large incurved fold. It resembles *L. exigua*, herein described, in size, but in the form of the columella it is entirely different. The aperture is about half the length of the shell.

Lymnæa coarctata.

Testâ fusiformi, tenuissimâ, obsoletè striatâ, diaphanâ, corneâ, imperforatâ; spirâ brevi, mucronatâ; suturis leviter impressis; anfractibus quaternis, subplanulatis; aperturâ grandi, ovatâ.

Shell fusiform, very thin, obsoletely striate, diaphanous, horn colour, imperforate; spire short, pointed; sutures slightly impressed; whorls four, rather flattened; aperture large, ovate.

Hab. Newport, Rhode Island. Col. Totten, United States Army. My Cabinet, and Cabinet of Col. Totten. Diam. .30, Length .55 of an inch.

Remarks.—This is one of the most delicate and fragile of the genus *Lymnæa*, which I have seen. It is allied to Mr. Say's *columella*, but may at once be distinguished by the compression of the superior part of the body whorl, which causes an acute angle in the superior part of the aperture. Under a rather powerful lens, some of the specimens may be perceived to have very minute revolving striæ. The aperture is two-thirds the length of the shell, and is inflated at the inferior part. The fold of the columella is delicate and incurved.

Lymnæa casta.

Testâ subfusiformi, subcrassâ, crebrè striatâ, luteâ, perforatâ; spirâ subelevatâ, acuminatâ; suturis impressis; anfractibus senis, convexis; aperturâ grandi, ovatâ.

Shell subfusiform, rather thick, closely striate, yellow, perforate; spire rather elevated, accuminate; sutures impressed; whorls six, convex; aperture large, ovate.

Hab. Poland, Ohio. Dr. Kirtland. My Cabinet, and Cabinets of Dr. Kirtland and T. G. Lea. Diam. .30, Length .58 of an inch.

Remarks.—The columella of this species is remarkably straight, and being reflected causes the lower part of the aperture to be slightly effuse. The last whorl is wrinkled. The aperture is more than half the length of the shell. It is allied to *L. decidiosus*, (Say,) but is a smaller species, has the spire more exserted, and a less curved fold. The perforation is very small. Dr. Kirtland kindly sent me many specimens several years since.

Lymnæa parva.

Testâ subturritâ, tenui, lævi, diaphanâ, corneâ, subperforatâ; spirâ elevatâ; suturis impressis; anfractibus quinis, convexis; aperturâ ellipticâ.

Shell subturrited, thin, smooth, diaphanous, horn colour, subperforate; spire elevated; sutures impressed; whorls five, convex; aperture elliptical.

Hab. Cincinnati, Ohio. T. G. Lea. My Cabinet, and Cabinet of T. G. Lea. Diam. .12, Length .22 of an inch.

Remarks.—This is the smallest species which has come under my notice. In general form it resembles *L. curta*, herein described. It is rather less inflated, has a longer aperture, and is more diminutive. The perforation, too, is smaller, and the columella more curved. The two specimens before me have the superior whorls black from the deposite of the oxide of iron. The aperture is about half the length of the shell.

Lymnæa curta.

Testâ subturritâ, subtenui, nitidâ, subdiaphanâ, luteâ, perforatâ; spirâ elevatâ; suturis impressis; anfractibus senis, convexis; aperturâ parvâ, ellipticâ.

Shell subturrited, rather thin, shining, subdiaphanous, yellow, perforate; spire elevated; sutures impressed; whorls six, convex; aperture small, elliptical.

Hab. Cincinnati, Ohio. T. G. Lea. Poland, Ohio. Dr. Kirtland. My Cabinet, and Cabinets of T. G. Lea, and Dr. Kirtland. Diam. .18, Length .32 of an inch.

Remarks.—A very small erect species resembling in the form of the aperture, a *Bulimus*, the fold being scarcely perceptible. In its general outline it resembles a *Paludina*, more than most *Lymnææ*. In these characters it is allied to *L. bulimoides* herein described. The aperture is rather more than one-third the length of the shell, and the last whorl is wrinkled. The columella is thickened, and reflected over the perforation.

Lymnæa strigosa.

Testâ longo-ovatâ, subobliquâ, diaphanâ, striatâ, corneâ, tenui, imperforatâ; spirâ brevi; suturis impressis; anfractibus quinis, subconvexis; aperturâ ovatâ.

Shell long oval, somewhat oblique, diaphanous, striate, horn-coloured, thin, imperforate; spire short; sutures impressed; whorls five, somewhat convex; aperture ovate.

Hab. Near Cincinnati, Ohio. T. G. Lea. My Cabinet, and Cabinet of T. G. Lea. Diam. .38, Length .75 of an inch.

Remarks.—This is a very thin fragile species somewhat resembling *L. columella*, (Say,) but may at once be distinguished from that species by its longer spire and less inflated body whorl. It is allied to *L. coarctata*, herein described, differing, however, in being more oblique and in having the whorls more inflated. The aperture is about three-fourths the length of the shell, and acutely angular above.

Lymnæa Kirtlandiana.

Testâ turritâ, tenui, enormiter striatâ, pallido-corneâ, imperforatâ; spirâ elevatâ, attenuatâ; suturis impressis; anfractibus senis, subconvexis; aperturâ angusto-ellipticâ.

Shell turrited, thin, irregularly striate, pale horn colour, imperforate; spire elevated, attenuate; sutures impressed; whorls six, slightly convex; aperture narrow elliptical.

Hab. Poland, Ohio. Dr. Kirtland. My Cabinet, and Cabinets of Dr. Kirtland and T. G. Lea. Diam. .26, Length .70 of an inch.

Remarks.—Many years since Dr. Kirtland sent me several specimens of this shell. I am not aware of its having yet been described. It may have been mistaken for *L. acuta*, (nobis,) being about the size and having the aspect of that shell. It may be distinguished from it, by having a longer and narrower body whorl, and a shorter and narrower aperture. The fold on the columella is smaller and the outer lip less curved. It is a smaller species than the *reflexa*, (Say,) has one whorl less and the mouth is longer. In other characters it resembles it, if the reflected lip be excepted. The aperture is rather less than half the length of the shell. Most of the specimens have an obscure brown line within the margin of the outer lip. The body whorl is disposed to be flattened, and is irregularly wrinkled. Under the lens the fine striæ which usually are found in the *Lymnææ*, may be observed beautifully displayed over the whole shell. The superior portion of all the specimens sent, have more or less deposite of the oxide of iron, which gives them the appearance of having two colours.

Lymnæa rubella.

Testâ ovato-conicâ, tenui, lævi, nitidâ, diaphanâ, rubellâ, imperforatâ; spirâ breviusculâ; suturis parvis; anfractibus quinis, subconvexis; aperturâ subgrandi, ovatâ.

Shell ovately conical, thin, smooth, shining, diaphanous, reddish, imperforate; spire rather short; sutures small; whorls five, somewhat convex; aperture rather large, ovate.

Hab. Oahu. Prof. Nuttall. My Cabinet, and Cabinet of Prof. Nuttall. Diam. .20, Length .35 of an inch.

Remarks.—This is a small species procured by Prof. Nuttall during his sojourn at the Sandwich Islands. It is rather smaller than Say's *modicella*, but may be distinguished by its reddish colour, bright surface and distinct fold. The aperture is more than half the length of the shell. The lip is margined by a red line on the inside where the specimen is mature. Some individuals are covered by a deposite of ferruginous matter.

PALUDINA. (LAMARCK.)

Lamarck described seven species of this genus, five of them being European. In the United States, the species are quite numerous. Mr. Say described thirteen, one of which (*dissimilis,*) properly belongs to his genus *Anculosa*, and three (*limosa, porata and lustrica,*) may be transferred to Dr. Gould's genus *Amnicola.* Fifteen others have been proposed by myself and other naturalists, and I now add three to the number.

PALUDINA REGULARIS.

Testâ subglobosâ, subcrassâ, virido-corneâ, lævi, imperforatâ; spirâ brevissimâ; suturis impressis; anfractibus quinis, convexis; aperturâ magnâ, ovatâ, intus cæruleâ.

Shell subglobose, rather thick, greenish horn colour, imperforate; spire very short; sutures impressed; whorls five, convex; aperture large, ovate, within bluish.

Hab. Ohio? T. G. Lea. My Cabinet, and Cabinet of T. G. Lea. Diam. .38, Length .52 of an inch.

Remarks.—A very distinct species with the body whorl about four-fifths the length of the shell. The whorls are very regular, giving the spire somewhat the appearance of a coil of rope. All the specimens before me are more or less incrusted with the oxide of iron. The aperture is inflated, and about three-fourths the length of the shell.

I am not positively sure that this species came from Ohio. By some accident the label has been misplaced, but I am under the impression it came with some other species from my brother at Cincinnati.

PALUDINA OBTUSA.

Testâ subcylindraceâ, subtenui, tenebroso-viridi, lævi, minutè perforatâ; spirâ brevi, ad apicem valdè obtusâ; suturis impressis; anfractibus quaternis, convexis; aperturâ parvâ, subrotundâ.

Shell subcylindrical, rather thin, dark green, smooth, slightly perforate; spire short, at the beaks very obtuse; sutures impressed; whorls four, convex; aperture small, nearly round.

Hab. Ohio. Dr. Kirtland. My Cabinet, and Cabinet of Dr. Kirtland. Diam. .07, Length .10 of an inch.

Remarks.—This is among the smallest of the genus, and may at once be distinguished by its obtuse apex which has the appearance almost of being truncate. The whorls do not decrease regularly from the lower one to the apex, the greatest diameter being apparently across the second whorl. In form, therefore, it has the aspect of a *Pupa.* It answers partly to the description of *Paludina Alleghaniensis,* (Green,) but seems to differ in the truncate appearance of the apex, and in the size. Two specimens were found in a box with some other small species, kindly sent to me by Dr. Kirtland. It is rather less than *P. Nickliniana,* and differs from it in being less tapering to the apex. It very closely resembles *P. viridis,* (Lam.) but is rather larger and more obtuse. There were no opercula to examine in these specimens. Aperture rather more than one-third the length of the shell.

Paludina Troostiana.

Testâ ventricoso-conoideâ, tenui, pellucidâ, luteo-corneâ, lævi, perforatâ; spirâ brevi; suturis valdè impressis; anfractibus quaternis, convexis; aperturâ magnâ, rotundatâ, albâ.

Shell ventricoso-conical, thin, pellucid, yellowish horn colour, smooth, perforate; spire short; sutures very much impressed; whorls four, convex; aperture large, rounded, white.

Hab. Tennessee. Prof. Troost. My Cabinet, and Cabinet of Prof. Troost. Diam. .68, Length .72 of an inch.

Remarks.—This is a subglobose species, differing from any which has come under my notice, in having the superior portion of the last whorl somewhat flattened, giving the shell a somewhat gibbous appearance. The operculum is rather of a light colour, and the plane of the aperture is very retuse at its base. It has a strong resemblance to *P. unicolor*, (Lamarck,) and perhaps a stronger one to *P. Maheyana*, (Grateloup.) It is more depressed in the spire than either, and the perforation is smaller than in the former, while it is nearly the size of that in the latter. The aperture is larger than either. Dr. Grateloup has very properly, I think, separated the Malabar species from that which was observed by Olivier in Egypt, and called *unicolor* by Lamarck. The Egyptian shell has a larger perforation, is darker in colour, and is a larger species. I call this after my friend Prof. Troost.

GENUS ANCULOSA. (Say.)

The genus *Anculosa* was proposed by Mr. Say, in the Journal of the Academy of Natural Sciences, vol. 2, p. 178, (1821,) for a new shell, which he then described under the name of *Melania prærosa.* I am not aware that he ever published a description of his proposed genus, but he then mentioned, that it did not correspond with the genus to which he "at present referred it," and he farther says, that "owing to the configuration of the base of the columella, if it is not a *Melanopsis*, it is probable its station will be between the genera *Melania* and *Achatina.*"

Four years afterwards, in describing a new species of the same group, under the name of *Melania subglobosa*, he says, "It is a second species of my proposed genus *Anculotus.*" He does not allude to the fact of having changed the termination of the name of his proposed genus. I have, therefore, always made use of the first, believing that the change was made through inadvertence. Mr. Haldeman, in his "Monograph of the Limniades," very properly uses *Anculosa*, while Mr. Conrad, in his "New Fresh Water Shells," with some other zoologists, uses *Anculotus.*

The generic characters of the shell of this animal, are difficult in some cases to seize, as the form of the aperture varies, as well as the form of the spire, (notwithstanding its name,) in many species.

Mr. Haldeman seems first to have observed the animal, which he found to differ from *Melania.* He describes it, as having a "very small foot, adapted for holding; animal sedentary; inhabits very rapid water, attached to stones." This of course separates it from *Melania*, and the "obvious characters" of the shell will generally distinguish it from both *Melania* and *Paludina*, as it has usually a callous columella, and a rounded aperture. The operculum, like that of *Melania*, is subspiral; at the same time it appears to me, that the point of radiation in that of *Anculosa* is usually nearer the margin. In the older specimens, the point of radiation is often directly on the margin. This, probably, is owing to part of it being worn away by the motion of the animal.

I am not aware, of this genus having been observed out of the United States. There have been seventeen species described, nearly all of which will stand, and I now propose to add four to that number.

Anculosa Troostiana.

Testâ ovato-conicâ, crassâ, minutè rugosâ, tenebroso-fuscâ; spirâ subelevatâ; suturis subimpressis; anfractibus planulatis; aperturâ rotundâ, intus cæruleâ; columellâ crassâ, vel albâ vel carneâ.

Shell ovately conical, thick, minutely rugose, dark brown; spire somewhat elevated; sutures rather impressed; whorls flattened; aperture rounded, within bluish; columella thick, white or flesh-coloured.

Hab. Tennessee. Professor Troost. My Cabinet, and Cabinet of Professor Troost. Diam. .50, Length .60 of an inch.

Remarks.—There are many specimens before me, all of which in form are unusually alike, for a species of *Anculosa*. It differs from other species which have come under my notice, in its spire, which is quite elevated, giving it the aspect of the genus *Melania*. Small irregular wrinkles, or granulations, may be observed over the whole surface in most specimens, and I believe this will generally be found to be more or less the case with most of the species.

Anculosa gibbosa.

Testâ subglobosâ, gibbosâ, crassâ, subnigrâ, crebrè striatâ; spirâ brevi; suturis impressis; anfractibus subplanulatis; aperturâ subquadrangulari, vel carneâ vel albidâ.

Shell subglobose, gibbous, thick, nearly black, thickly striate; spire short; sutures impressed; whorls rather flattened; aperture subquadrangular, flesh-coloured or whitish.

Hab. Tennessee. Professor Troost. My Cabinet, and Cabinet of Prof. Troost. Diam. .50, Length .68 of an inch.

Remarks.—This species is about the size of *An. subglobosa*, (Say.) It is not so regularly rounded, being flattened on the upper part of the whorl. The striæ are minute, and seem to be formed by the lines of growth. There is quite a callus on the superior part of the columella, the middle part being deeply impressed. The number of whorls could not be ascertained from my specimens, all of them being more or less eroded.

Anculosa carinata.

Testâ ovato-conoideâ, carinatâ, tenebroso-olivaceâ; spirâ breviusculâ; suturis parvis; anfractibus senis; aperturâ parvâ, rotundâ, intus albidâ, sulcatâ; columellâ subcrassâ, purpureâ.

Shell ovately conical, carinate, dark olive; spire rather short; sutures small; whorls six; aperture small, round, within whitish, sulcate; columella rather thick, purple.

Hab. Roanoke River, Lafayette. J. A. Warder, M. D. My Cabinet, and Cabinet of Dr. Warder. Diam. .38, Length .52 of an inch.

Remarks.—A single specimen only of this interesting species was sent to me by Dr. Warder. It has some resemblance to *Anculosa dissimilis*, (Say.) It differs in having a smaller and rounder aperture, and in having three *carinæ*, the middle one being the largest. The aperture is rather more than one-third the length of the shell. The carinæ are acute.

Anculosa variabilis.

Testâ obtuso-conoideâ, crassâ, vel fasciatâ vel corneâ vel carinatâ vel lævi; suturis linearibus; anfractibus senis, planulatis; aperturâ magnâ, subrotundâ; columellâ crassâ, vel albâ vel purpureâ.

Shell obtusely conical, thick, either banded or horn-coloured, carinate or smooth; sutures linear; whorls six, flattened; aperture large, nearly round; columella thick, white or purple.

Hab. Roanoke River, Lafayette, and near Shenandoah Spring Brook. J. A. Warder, M. D. My Cabinet, and Cabinets of Dr. Warder and T. G. Lea, Cincinnati. Diam. .38, Length .56 of an inch.

Remarks.—Three specimens are before me, all of which differ more or less. Two of them are rather acutely carinate, with a dark epidermis and three rather large bands, the other is of a rather light horn colour with indistinct bands in the interior, and having no carina on the lower whorl. On the columella, there is a slight swelling. The aperture is about one-half the length of the shell.

AMNICOLA. (GOULD.)

The genus *Amnicola*, proposed by Dr. Gould, and adopted by Mr. Haldeman, in his table of "Water-breathing Lymniades," is separated from the genus *Paludina; Paludina lustrica*, (Say,) being made the type. There seems to be sufficient reason for this division, as the animal is different, and the operculum subspiral, differing in this respect entirely from that of *Paludina*, which is concentric.

It is difficult in the present state of our knowledge of these small shells to say how many species are known, as the animals and opercula of all the small species of *Paludina* have not yet been observed. *P. limosa* (Say,) and *porata* (Say,) will belong to this genus.*

AMNICOLA ORBICULATA.

Testâ orbiculatâ, subtenui, luteolâ, lævi, umbilicatâ; spirâ brevi; suturis valdè impressis; anfractibus quinis, inflatis; aperturâ magnâ, rotundâ.

Shell orbicular, rather thin, yellowish, smooth, umbilicate; spire short; sutures much impressed; whorls five, inflated; aperture large, round.

Hab. Springfield, Ohio. T. G. Lea. Schuylkill? near Philadelphia. My Cabinet, and Cabinet of T. G. Lea. Diam. .18, Length .18 of an inch.

Remarks.—This species is very closely allied to *Am. parva*, and may perhaps prove to be only a variety of it. The specimens before me are all larger, and they appear to be more globose. The aperture is about one-half the length of the shell. I found a single specimen of this species among many small shells which were thrown together in a box, as being collected from our vicinity. It may be possible that it is an Ohio specimen gotten by accident into the box.†

AMNICOLA PARVA.

Testâ obtuso-conicâ, subtenui, luteolâ, lævi, umbilicatâ; spirâ brevi; suturis impressis; anfractibus quaternis, inflatis; aperturâ magnâ subrotundâ.

Shell obtusely conical, rather thin, yellowish, smooth, umbilicate; spire short; sutures impressed; whorls four, inflated; aperture large, nearly round.

Hab. Springfield, Ohio. T. G. Lea. My Cabinet, and Cabinet of T. G. Lea. Diam. .15, Length .18 of an inch.

Remarks.—The shell described by Mr. Anthony as *Paludina Cincinnatiensis*, resembles this species, but it is more elevated in the spire, and is a larger shell. It is more

* The shell described by me in vol. 6, page 22, of the Transactions, as *Paludina pallida*, and previously by Mr. Say as *Melania isogona*, but which I had not before seen, has been carefully examined by my brother T. G. Lea of Cincinnati, as to the form and habits of the animal. There can no longer be any doubt of its belonging to the genus *Amnicola;* it should therefore be called *Amnicola isogona.*

† Since the above was written, I have observed a single specimen of this shell among those in the Academy of Natural Sciences, with the true *porata*, from Cayuga Lake. It is, therefore, probable that it exists in our rivers flowing into the Atlantic.

nearly allied to *Amnicola orbiculata*, herein described, but may be distinguished by its being a smaller shell, and being less round in the aperture. The base of the lip is disposed to be slightly angular: the aperture is about one-half the length of the shell.

IO. (LEA.)

The genus *Io* was proposed by me for Mr. Say's *Fusus fluviatilis*. I subsequently added the *spinosa*, which may perhaps prove to be only a variety of the other. The *tenebrosa* now proposed, will make three species of this genus.

IO TENEBROSA.

Testâ fusiformi, subtenui, subnigrâ, lævi; spirâ conicâ; suturis vix impressis; anfractibus senis, subplanulatis; aperturâ enormiter pyriformi, intus purpureâ.

Shell fusiform, rather thin, nearly black, smooth; spire conical; sutures scarcely impressed; whorls six, flattened; aperture irregularly pear-shaped, within purple.

Hab. Tennessee. S. M. Edgar. My Cabinet, and Cabinets of Mr. Edgar and Prof. Troost. Diam. .48, Length .75 of an inch.

Remarks.—A single specimen only was brought by Mr. Edgar from Tennessee. It is a small specimen, and may be immature. After a good deal of hesitation, I have determined to give it a place among the species. It seems to me to be very distinct in colour. The channel is more curved to the left and backward, than in Mr. Say's species. It has no trace of spines or tubercles, and is dark all over. I do not know if it ever occurs banded.

Read June 18, 1841.

HELIX MOBILIANA.

Testâ subglobosâ, rufo-corneâ, nitidâ, perforatâ; spirâ brevi, obtusâ; suturis impressis; anfractibus senis, convexis; aperturâ lunatâ; labro reflexo.

Shell subglobose, reddish horn colour, shining, perforate; spire short, obtuse; sutures impressed; whorls six, convex; aperture lunate; lip reflexed.

Hab. Vicinity of Mobile, Alabama. Mr. Charles Lea. My Cabinet, and Cabinet of T. G. Lea. Diam. .30, Length .25 of an inch.

Remarks.—My brother, T. G. Lea, sent me several of this species, with other *Helices* collected near Mobile. A single specimen only was perfect in the lip, the remainder being immature. It is not easily confounded with any other of our species. In form it is somewhat like *H. jejuna*, (Say,) but is not more than one-fourth the size, and differs in colour. There is rather a deep groove behind the lip, which is reddish. The umbilicus is small.

HELIX MINUTISSIMA.

Testâ subglobosâ, suprà obtuso-conoideâ, subtus convexâ, fusco-corneâ, minutissimè striatâ, umbilicatâ; spirâ brevi; suturis impressis; anfractibus quaternis, rotundis; aperturâ subrotundâ; labro acuto.

Shell subglobose, above obtusely conical, below convex; brown horn colour, very minutely striate, umbilicated; spire short; sutures impressed; whorls four, round; aperture nearly round; lip acute.

Hab. Vicinity of Cincinnati. T. G. Lea. My Cabinet and Cabinet of T. G. Lea. Diam. .06, Length .04 of an inch.

Remarks.—This is the smallest species, in our country, which has come under my notice. Its very minute longitudinal striæ can only be observed by a powerful lens. The umbilicus is rather large and deep. It is nearly the form of *H. labyrinthica*, (Say,) but is a smaller species, is differently striated, and has no teeth. My brother sent me three specimens, which he informs me were found under wet sticks, and on the margin of a pond.

Melania turgida.

Testâ lævi, obtuso-conicâ, inflatâ, crassâ, fasciatâ; spirâ brevi, ad apicem acuminatâ; suturis leviter impressis; anfractibus septenis, planulatis; aperturâ parvâ, formam trapezii habente; columellâ incrassatâ, albâ.

Shell smooth, obtusely conical, inflated, thick, banded; spire short, pointed at the apex; sutures slightly impressed; whorls seven, flattened; aperture small, trapezoidal; columella thickened, white.

Hab. Holston River, East Tennessee. Prof. Troost, and S. M. Edgar. My Cabinet, and Cabinets of Prof. Troost and S. M. Edgar. Diam. .35, Length .55 of an inch.

Remarks.—This is a very short and thick species, having a very large body whorl disposed to be obtusely angular at the middle. The number of bands varies. One of the specimens has a single one, another has two bands, and five have five bands, there being seven specimens before me. That with a single band is of a bright yellow; the others are of a greenish yellow. The aperture is nearly one-half the length of the shell, and twisted at the base.

Melania glabra.

Testâ lævi, conoideâ, subtenui, nitidâ, tenebroso-castaneâ; spirâ subelevatâ; suturis leviter impressis; anfractibus subplanulatis; aperturâ elongatâ, formam trapezii habente, intus purpureâ; columellâ incurvâ.

Shell smooth, conical, rather thin, shining, dark chestnut colour; spire rather elevated; sutures slightly impressed; whorls rather flattened; aperture elongated, trapezoidal, purplish within, columella incurved.

Hab. Holston River, East Tennessee. Prof. Troost, and S. M. Edgar. My Cabinet, and Cabinets of Prof. Troost and Mr. Edgar. Diam. .32, Length .70 of an inch.

Remarks.—The apex in all the specimens before me is slightly eroded, and therefore the number of the whorls cannot be accurately ascertained; it may be six or seven. The aperture is more than one-third the length of the shell. The superior whorls are disposed to be carinate, and below the sutures the colour is lighter. The columella is much incurved. Within the aperture, indistinct confluent bands may be observed. These are scarcely observable without, but give the shell a very dark aspect, somewhat like *M. rufa*, (nobis.) It is very different, however, in form, from that species.

Melania perfusca.

Testâ lævi, conoideâ, subcrassâ, tenebroso-fuscâ; spirâ exsertâ; suturis linearibus; anfractibus subplanulatis; aperturâ grandi, inflatâ, ovatâ, intus pallido-purpureâ.

Shell smooth, conical, rather thick, dark brown; spire exserted; sutures linear; whorls rather flattened; aperture large, inflated, ovate, within pale purple.

Hab. Calf-killer Creek. Tennessee. S. M. Edgar. My Cabinet and Cabinet of Mr. Edgar. Diam. .50, Length 1 inch.

Remarks.—A single specimen, with the spire truncate, is before me. The lower portion is perfect. The apex being destroyed, the number of whorls cannot be ascertained.

The aperture is, I presume, rather more than one-third the length of the shell. The lower part of the margin protrudes considerably. It seems to be nearly allied to *M. ebenum*, (nobis,) but is a larger shell, more inflated, and has a larger aperture, being less elliptical.

Melania picta.

Testâ lævi, obtuso-conicâ, crassâ, subfusiformi, subviridi, fasciatâ; spirâ subelevatâ; suturis impressis, supernè exaratis; anfractibus octonis, planulatis; aperturâ elongatâ, formam trapezii habente; columellâ incurvâ.

Shell smooth, obtusely conical, thick, subfusiform, greenish, banded; spire rather elevated; sutures impressed, above furrowed; whorls eight, flattened; aperture elongated, trapezoidal; columella incurved.

Hab. Holston River, East Tennessee. Prof. Troost, and S. M. Edgar. My Cabinet, and Cabinets of Prof. Troost and S. M. Edgar. Diam. .30, Length .70 of an inch.

Remarks.—The four specimens before me have each three bands, which with the yellowish tint below the sutures give the shell a lively appearance. The superior whorls are disposed to be bicarinate, and the lower carina being covered with the whorl below, causes a furrow along the suture. The aperture is more than one-third the length of the shell, angular at the base, with rather a large sinus.

Melania impressa.

Testâ transversè et crebrissimè sulcatâ, fusiformi, crassâ, rufo-fuscâ; spirâ obtusâ; suturis impressis; anfractibus senis, planulatis; aperturâ ellipticâ, subgrandi, ad basim angulatâ, intus albâ.

Shell transversely and thickly sulcate, fusiform, thick, reddish brown; spire obtuse; sutures impressed; whorls six, flattened; aperture elliptical, rather large, angular at the base, within white.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Foreman, and Mr. J. Clark, of Cincinnati. Diam. .48, Length .81 of an inch.

Remarks.—Dr. Griffith received a single specimen only of this singularly marked species, and this is not entirely perfect at the spire or aperture. The whole surface of this specimen is covered with very minute impressed revolving lines, the body whorl having twenty-four. They are nearly equidistant and very regular. Its aperture is nearly one-half the length of the shell. On the superior part of the columella, there is quite a large callus.* In form and size, it closely resembles the *M. robusta*, herein described.

Melania robusta.

Testâ striatâ, fusiformi, crassâ, luteolâ; spirâ obtusâ; suturis subimpressis; anfractibus senis, subconvexis; aperturâ ellipticâ, magnâ, ad basim angulatâ, intus albâ.

Shell striate, fusiform, thick, yellowish; spire obtuse; sutures rather impressed; whorls six, rather convex; aperture elliptical, large, angular at the base, within white.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Foreman, and Mr. J. Clark. Diam. .60, Length .91 of an inch.

Remarks.—A single specimen, only, of this fine species was obtained by Dr. Griffith. It presents four rather distant large revolving striæ on the body whorl, and two on the next. In other specimens these may be found more numerous, or entirely wanting. The aperture is nearly half the length of the shell.† In form and size, it very closely agrees with *M. impressa*, herein described.

* Other specimens subsequently received, confirm nearly all the other characters.

† In specimens subsequently received, the striæ were found to differ but little.

MELANIA JAYANA.

Testâ tuberculatâ, subfusiformi, crassâ, pallido-corneâ; spirâ exsertâ; suturis linearibus, curvatis; anfractibus subconvexis, medio impressis, tuberculorum duplici serie cinctis; columellâ incurvatâ, supernè incrassatâ; aperturâ formam trapezii habente, intus albidâ.

Shell tuberculate, subfusiform, thick, pale horn colour; spire exserted; sutures linear and curved; whorls rather convex, impressed in the middle, surrounded by a double series of tubercles; columella incurved, thickened above; aperture trapezoidal, whitish within.

Hab. Cany Fork. De Kalb county, Tennessee. Prof. Troost. My Cabinet, and Cabinets of Dr. Jay and Prof. Troost. Diam. .78, Length 1.20 of an inch.

Remarks.—Dr. Jay had two specimens of this species, and I owe to his kindness the possession of one of them. It very closely resembles the *M. armigera*, (Say,) in most of its characters, but may at once be distinguished by the double row of tubercles, the *armigera* never possessing distinctly more than one row: below the sutures, however, there are sometimes imperfect tubercles, which are caused by the protrusion of the tubercles of the superior whorl. This protrusion also takes place in the *Jayana*, but causes in it only a constant curvature in the linear suture.

The apex of the specimen is much eroded, and consequently I am not sure of the number of the whorls, probably eight or nine. The aperture may be rather more than one-third the length of the shell, and is acutely angular at the base, with rather a deep sinus. The callus above causes a considerable sinus there. The operculum is dark brown, the radii converging at the lower interior edge.

ANCULOSA RUBIGINOSA.

Testâ ovato-gibbosâ, crassâ, lævi, rubiginosâ; spirâ subelevatâ; suturis impressis; anfractibus planulatis; aperturâ enormiter ovatâ, intus albidâ; columellâ crassâ, tenebroso-purpureâ.

Shell ovately gibbous, thick, smooth, rusty colour; spire rather elevated; sutures impressed; whorls flattened; aperture irregularly ovate, within whitish; columella thick, dark purple.

Hab. Warrior River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Foreman, and Mr. Clark. Diam. .40, Length .60 of an inch.

Remarks.—A single, and not a very perfect specimen is before me. The middle of the whorl is flattened, indeed a little impressed, and this causes a curve in the outer lip. It is obscurely banded, and the whole of the columella is purple. The aperture is nearly two-thirds the length of the shell. The spire is more exserted than usual in the *Anculosæ*, but not perfect in this specimen. Four whorls are perceptible.*

ANCULOSA GRIFFITHIANA.

Testâ ovato-gibbosâ, crassâ, crebrè et transversè striatâ, fasciatâ; suturis impressis; anfractibus quaternis, planulatis; aperturâ ovatâ, intus fasciatâ; columellâ crassâ, tenebroso-purpureâ.

Shell ovately gibbous, thick, closely and transversely striate, banded; sutures impressed; whorls four, flattened; aperture ovate, within banded; columella thick, dark-purple.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Foreman, and Mr. J. Clark. Diam. .50, Length .60 of an inch.

Remarks.—The distinctive characters of this species, are the transverse striæ and the flattened side. This flatness causes an obtuse angle below, and one above. One of the two specimens, under examination, is more banded, and has a less number of striæ than the other. The aperture is nearly three-fourths the length of the shell.

* Several very fine specimens have been since received, from Dr. Foreman.

ANCULOSA TUBERCULATA.

Testâ ovatâ, crassâ, supernè, tuberculatâ, fuscâ; spirâ brevi; suturis vix impressis; anfractibus subconvexis; aperturâ ovatâ, intus carneâ; columellâ crassâ, maculatâ.

Shell ovate, thick, above tuberculate, brown; spire short; sutures scarcely impressed; whorls slightly convex; aperture ovate, within flesh-coloured; columella thick and spotted.

Hab. Warrior River, Alabama. Dr. Brumby. Cabinet of Dr. Griffith. Diam. .38, Length .50 of an inch.

Remarks.—The above description is made from a single specimen, which is truncate at the apex, as the species of this genus usually are. Three whorls are visible. In a perfect state, it probably has four. The specimen before me has two rows of tubercles. On the superior part of the whorl, and below these, are two parallel indistinct lines, which may, in other individuals, rise into tubercles. In the interior, two purple bands are visible. On the middle of the columella there is a large purple spot. This may not occur in all specimens. The aperture is about two-thirds the length of the shell.

VALVATA BICARINATA.

Testâ orbiculari, supernè planulatâ, bicarinatâ, subcrassâ, supernè corneâ, infernè albidâ, latè umbilicatâ; suturis impressis; spirâ depressâ; anfractibus quaternis, convexis; aperturâ rotundâ, intus albidâ.

Shell orbicular, flattened above, bicarinate, rather thick, horn-coloured above, whitish below, widely umbilicate; sutures impressed; spire depressed; whorls four, convex; aperture rounded, whitish within.

Animal.—Body rather short and white, head large, tapering, slightly enlarged at the anterior termination, with a black mark passing from the neck between the eyes, tapering off and reaching nearly to the end of the snout, where there are two oblique black marks bordered in front by white, and accompanied behind by several irregular white spots, the anterior ones being the larger. Branchia translucent, superior portion blackish, bordered with white spots and occasionally obtruded; eyes round and deep black, placed at the posterior base of the tentacula, surrounded by a white area; tentacula long, rather tapering, obtuse at the end; filament rather short, translucent with longitudinal white lines; foot wide and furcate anteriorly, where minute white spots may be observed. Operculum thin, semitransparent, light horn colour, increment circular and rather coarse.

Hab. Schuylkill River, west side, below Permanent Bridge. H. C. Lea. My Cabinet. Diam. .30, Length .12 of an inch.

Remarks.—In the form of the shell, this species closely resembles the *tricarinata*, (Say.) It differs in having but two carinæ, in having a wider umbilicus, and the spire is more depressed. The animals of the two species differ in form and colour more than the shells.

The head of the *tricarinata* is more cylindrical and enlarged at the termination, where it somewhat resembles the snout of the hog, while that of the *bicarinata* is more conical and without so sudden an enlargement at the end. The colour of the *bicarinata* is lighter. In the black markings they also differ. In the *tricarinata* there is a single blotch anterior to the area between the eyes. In the *bicarinata* this extends also behind this area; and in addition may be observed two quite black marks above the mouth, which the *tricarinata* does not seem to have. The tentacula of the *bicarinata* are larger and more filiform. When in motion, the anterior portions of the lobes of the foot are pointed, and recurved or hooked.

The shell of the *bicarinata* is quite light-coloured beneath, and rather a dark horn colour above, the change of colour taking place a short distance above the periphery of the whorl, between which and the superior carina it is quite dark. The superior carina is large and erect, the inferior one is smaller. All the whorls are visible beneath. Very minute longitudinal striæ cover the whole surface.

Having several living specimens of both these species, I observed them closely with a lens while under water in a glass vessel. On the 15th of May, while I had a *tricarinata* at the focus of my lens, I observed a small apple green, globose object, passing from under the aperture of the shell. This was shortly followed by others, and soon a transparent gelatinous mass became visible. This mass was passed slowly over the right side of the neck, under the pectiniform moveable branchiæ, until entirely discharged against the perpendicular side of the vessel in which it was kept, and there the mass remained attached, the parent having abandoned it immediately. The time was fifteen minutes from the first appearance of the mass until it was fairly discharged. The green globules were the ova, of which I counted thirty in the transparent, globose gelatinous mass, which was not more in diameter than one-twentieth of an inch, the transverse diameter of the shell being about four-twentieths of an inch. In other cases, I found the number of ova to differ; some masses having only ten or twelve.

On the 23d, (eight days after) the ova were so far advanced, as to be changed to a dull faded green, the mass enveloping them having changed by degrees in transparency, and becoming of a slightly ferruginous colour. As yet, no change of bulk or arrangement was observed.

On the 29th, (fourteen days after,) the mass was observed to be opened, and with a lens of considerable power I could plainly see a motion in most of the ova, the rounded form of the shell being easily discerned within.

On the 30th, (fifteen days after) most of the young shells had broken their filmy bonds, only six or seven remaining: their motion was very apparent, and their minute black eyes could be plainly seen. I observed to-day, for the first time, that the *valvata* had the power of swimming, inverted from the surface of the water, like the *Planorbes*, *Physæ*, &c. Most of the young were in that position, and could move comparatively fast. The action of the mouth in the adult, when swimming in this way, was constant, and changed from an oval to a circular form.

From the above observations, we may conclude that the *valvata tricarinata* requires from fourteen to fifteen days to be perfected in the ovum, from the time it is ejected and abandoned by its parent. The *bicarinata*, I have no doubt, requires the same time. Numerous globules were deposited about the glass, which globules appeared all to resemble each other, and nearly all the individuals were of the species *bicarinata*.

Paludina angulata.

Testâ inflatâ, tenui, fuscâ, supernè subvaricosâ, infernè transversè et minutè striatâ, minutè perforatâ; spirâ breviusculâ, ad apicem tenebrosâ; suturis impressis; anfractibus quinis, in medio angulatis; aperturâ magnâ, subtriangulatâ, intus subrubiginosâ.

Shell inflated, thin, brown, above somewhat varicose, below transversely and minutely striate, minutely perforate; spire rather short, dark at the apex; sutures impressed; whorls five, angular in the middle; aperture large, subtriangular, within subrubiginous.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Jay, Dr. Foreman, T. G. Lea, and J. Clark. Diam. .80, Length 1.05 of an inch.

Remarks.—This is a very distinct species, being more angular than any I have seen. In the specimen before me, there are three irregular transverse impressions, two above the angle, and one immediately below. The striæ are more distinct on the lower half of the whorl. The first three whorls are very dark. The aperture is nearly one-half the length of the shell, and quite angular at the base.*

Paludina Coosaensis.

Testâ subglobosâ, tenui, pallidâ, sublævi, perforatâ; spirâ brevi; suturis valdè impressis; anfractibus quinis, rotundatis; aperturâ magnâ, subrotundâ, intus albidâ.

Shell subglobose, thin, pale, rather smooth, perforate; spire short; sutures very much impressed; whorls five, round; aperture large, nearly round, within whitish.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith and Dr. Foreman. Diam. .58, Length .62 of an inch.

Remarks.—This species is remarkable for its round whorls, its width and large deep sutures. The superior part of the whorls is somewhat flattened. The colour is remarkably pale, nearly white. The epidermis is very thin, and under the lens displays very minute, rather regular longitudinal striæ crossed on the body whorl by obsolete striæ. The aperture is nearly one-half the length of the shell.

Paludina cyclostomatiformis.

Testâ subcylindraceâ, subcrassâ, pallido-corneâ, lævi, perforatâ; spirâ exsertâ, ad apicem roseâ, obtusâ; suturis valdè impressis; anfractibus quinis, rotundatis; aperturâ parvâ, subrotundâ, intus salmonis colore tinctâ.

Shell subcylindrical, rather thick, pale horn colour, smooth, imperforate; spire exserted, at the apex rose-coloured and obtuse; sutures very much impressed; whorls five, rounded; aperture small, nearly round, within salmon-coloured.

Hab. Coosa River, Alabama. Dr. Brumby. My Cabinet, and Cabinets of Dr. Griffith, Dr. Jay, L. W. Sloat, and Dr. Foreman. Diam. .32, Length .82 of an inch.

Remarks.—This is a very remarkable species assuming very much the form of an exserted *Cyclostoma.* A single, somewhat worn specimen only, was received. The aperture is rather more than one-third the length of the shell. Its subcylindrical form is very remarkable.†

* Since the above was written, I have received more mature and perfect specimens. They differ from the one described in being darker in the epidermis, and in having four purple broad bands, which are very distinct within the aperture. In these specimens, there is a series of indistinct tubercles above the periphery of the last whorl.

† Since the above description was written, Dr. Jay and Dr. Foreman have placed in my hands specimens from the same locality. The epidermis is perfect, and they are of a greenish horn colour. The interior of the aperture is bluish, while the apex is slightly salmon-coloured.

Read December 16, 1842.

In a paper which I read before this society, in January of last year, I added fifty-seven new species to the genus *Melania*, and in a subsequent paper, several more were added. Recently Dr. E. Foreman, of Baltimore, very kindly sent to me all the specimens from his cabinet, of the family *Melaniana* and *Peristomiana*, with permission to describe what I might find new. There appeared to me to be twelve undescribed *Melaniæ*, four *Anculosæ* and two *Paludinæ*. These I have described in this paper. In my former memoir, I stated that Lamarck does not mention a single species of *Melania* as inhabiting the rivers of Europe, but since the publication of his great work, Dr. Philippi and some other zoologists, have described a few species from Italy and the Eastern parts of Europe.

The genus *Melania* is greatly developed in the United States, while not a single species has been observed in Great Britain or the western part of the continent. When Lamarck issued his 6th vol. in 1822, he was acquainted with only sixteen recent species, nearly all of which, he says, are exotic to Europe. Since that period our knowledge of this genus has greatly extended, and my catalogue now includes the names of two hundred and sixty-six species. This does not include the *Anculosæ*, which Mr. Say very properly separated from the *Melaniæ*. My catalogue of these embraces thirty-three species.

Of the two hundred and sixty-six* species of the genus *Melaniæ*, forty-four† are in a fossil state, leaving two hundred and twenty-two recent. Of these sixty-one are exotic, and one hundred and sixty-one indigenous. Eighty-eight of these are described in my papers, including the present one, presented to this society.

It is remarkable, that while such a vast development of this genus has taken place here, that as yet we have not observed a single species of the nearly allied genus *Melanopsis* in North America. It ranges in a variety of species from the Caucasus to the Alps. I have in my cabinet three supposed species from South America. One of these, the *crenocarina* of Moricand (a very interesting shell) will, I think, have to be removed to a new genus. The *Braziliensis* of the same author approximates more closely to Lamarck's characteristics, but the callus is absent; and the same remark applies to the *maculata*, (nobis.‡)

* Of these there may be probably twelve or fifteen duplications.

† For many years I have believed that many of Lamarck's fossil *Melaniæ* belonged to other genera, and I find that M. Deshayes, in his notes to the new edition of Lamarck, mentions six as certainly not *Melaniæ*.

‡ Having inadvertently in my former papers duplicated some names, I propose the following changes, *Melania plicatula* to *M. Deshayesiana*, that name being preoccupied by Deshayes. *Melania plicata*, to *M. Menkiana*, that name being preoccupied by Dr. Menke. *Melania exarata*, to *M. arata*, that name being preoccupied by Dr. Menke. *Planorbis lens* to *P. Brogniartiana*, that name being preoccupied by M. A. Brogniart.

Melania Vanuxemiana.*

Testâ striatâ, obtuso-conicâ, solidâ, luteolâ, fasciatâ; spirâ breviusculâ; suturis impressis; anfractibus senis, subconvexis; columellâ supernè incrassatâ; aperturâ ovatâ, albâ.

Shell striate, obtusely conical, solid, yellowish, banded; spire rather short; sutures impressed; whorls six, somewhat convex; columella thickened above; aperture ovate, white.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .42, Length, .73 of an inch.

Remarks.—A very pretty symmetrical species, having the mouth rather more than one-third the length of the shell. A single specimen only is before me. It has five nearly equidistant coarse striæ, and four purple bands. It is somewhat like *M. ovalis*, herein described, but has a wider aperture, and a higher spire. I name it after my friend, Prof. Vanuxem.

Melania ovalis.

Testâ striatâ, fusiformi, solidâ, luteâ, fasciatâ; suturis valdè impressis; anfractibus senis, subconvexis; aperturâ ovatâ, constrictâ, intus albidâ.

Shell striate, fusiform, solid, yellow, banded; sutures much impressed; whorls six, rather convex; aperture oval, narrow, whitish within.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .40, Length .62 of an inch.

Remarks.—A number of specimens were kindly sent by Dr. Foreman for my inspection, several of which are young, exhibiting on the first two or three whorls very distinct folds. Those of the larger specimens are worn off. The mature specimens are remarkable for their irregularly elliptical form, generally having transverse striæ over the whole surface. The aperture is very regularly ovate, fully the half of the length of the shell.

Melania Haysiana.

Testâ striatâ, subcylindraceâ, solidâ, luteo-fuscâ; spirâ subelevatâ; suturis impressis; anfractibus planulatis; aperturâ parvâ, ellipticâ.

Shell striate, subcylindrical, solid, yellowish brown; spire rather elevated; sutures impressed; whorls flattened; aperture small, elliptical.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .43, Length .90 of an inch.

Remarks.—Dr. Foreman submitted many specimens of this species to my examination, and I find them differing very much in form and colour. Some individuals are so full of dark purple bands as to give them a dark hue; others are devoid of bands entirely, and are yellowish. The aperture is contracted, and about one-third the length of the shell. The transverse raised striæ, in some, cover nearly all the whorls, while others are almost or entirely free from them. In general outline it is allied to *M. picta*, (nobis,) all the specimens being more or less eroded at the beaks. I am unable to state the number of whorls, but believe them to be eight or nine. I dedicate this species to my friend Isaac Hays, M. D.

Melania excisa.

Testâ striatâ, subfusiformi, subcrassâ, luteolâ; spirâ ovato-conicâ; suturis impressis; anfractibus planulatis; aperturâ supernè excisâ, parvâ, ellipticâ, albâ.

Shell striate, subfusiform, rather thick, yellowish; spire ovately conical; sutures impressed; whorls flattened; aperture cut out above, small, elliptical, white.

* In this paper I adopt the rules of construction laid down in botanical nomenclature, (see Linley's Elements,) where it is usual, when species are named after individuals who discover them, to use the genitive; when in compliment, the adjective.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .40, Length .64 of an inch.

Remarks.—This shell is very remarkable for the cut in the superior part of the outer lip, very similar to some species of *Pleurotoma*. This cut extends nearly one-fifth round the whorl, leaving immediately below the suture an elevated ridge. There are nearly three whorls of this specimen perfect, and the cicatrix shows the cut to have extended in due proportion thus far. The aperture is rather small, and rather more than one-third the length of the shell. On the spire there is a slight disposition to plication. The apex being eroded, the number of whorls is not certain, perhaps six. This specimen has three revolving purple bands.

For the first time we now observe in the *Melaniana* a species with a pleurotomose lip. In all its other characters it is a true *Melania* resembling most, perhaps, *M. Vanuxemiana*, herein described. A character so anomalous in this family, caused me to doubt the propriety of retaining it here. But the absence of the animal, and the fact that I have before me a new species, with the other characteristics of the genus *Anculosa*, having in a minor degree this pleurotomose character, induces me merely to propose a name provisionally for it. The animal may be on examination different; should it prove so, it may then be called *Schizostoma*, Σχίζω, to cut, Στόμα, a mouth.

Under the microscope may be observed, in this species, very minute undulating revolving striæ.

Melania Ordiana.

Testâ striatâ, pyramidatâ, crassâ, tenebroso-fuscâ; spirâ exsertâ; suturis valdè impressis; anfractibus planulatis; aperturâ formam rhombi habente, parvâ, albidâ.

Shell striate, pyramidal, thick, dark brown; spire drawn out; sutures deeply impressed; whorls flattened; aperture rhombic, small, whitish.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .52, Length 1.25 of an inch.

Remarks.—A single specimen only of this species is before me, and that unfortunately is decollate, in having lost, probably, four or five whorls: the four lower whorls are perfect. The outer lip is much curved, giving the aperture an auger-like appearance, and causing the channel to be much impressed. On the body whorl there are four rather distant elevated striæ, three of which are large: the whorls above exhibit two. The aperture is about one-fourth the length of the shell. This species resembles *M. canaliculata*, (Say,) and *M. annulifera*, (Con.) It has not the channel of the former, and differs from the latter, in having deeply impressed sutures in the form of the aperture, in the outer lip, and in the striæ. I dedicate it to my old friend, George Ord, Esq.

Melania brevis.

Testâ striatâ, subcylindraceâ, subsolidâ, luteâ; spirâ breviusculâ; suturis impressis; anfractibus planulatis; columellâ supernè incrassatâ; aperturâ ovatâ, albâ.

Shell striate, subcylindrical, somewhat solid, yellow; spire rather short; sutures impressed; whorls flattened; columella thickened above; aperture ovate, white.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .41, Length .60 of an inch.

Remarks.—A single specimen only of this species is before me. The apex being eroded, the number of whorls cannot with certainty be ascertained: there appear to be about five. On this specimen, there are eight indistinct impressed striæ, and several low, irregular folds on the body whorl, which may be more distinct on the superior whorls when found perfect. The aperture is about half the length of the shell.

Melania oliva.

Testâ striatâ, ellipticâ, solidâ, fuscâ; spirâ breviusculâ; suturis valdè impressis; anfractibus convexis; columellâ incurvatâ, supernè incrassatâ; aperturâ ovata, albâ.

Shell striate, elliptical, solid, brown; spire rather short; sutures much impressed; whorls convex; columella incurved, thickened above; aperture ovate, white.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinet of Dr. Foreman. Diam. .50, Length 1 inch.

Remarks.—This is a ponderous and rather large species, with not very distinct striæ on the few specimens before me. The superior part of the columella is quite callous. The apex of each is too much eroded to designate the number of the whorls. The aperture is rather small, and contracted. One of the specimens is rather coarsely plicate.

Melania Foremani.

Testâ tuberculatâ, pyramidatâ, subcrassâ, luteo-fuscâ; spirâ elevatâ; suturis enormiter lineatis; anfractibus novenis, planulatis; aperturâ productâ, ad basim angulata et canaliculatâ, intus albidâ.

Shell tuberculate, pyramidal, rather thick, yellowish brown; spire elevated; sutures irregularly lined; whorls nine, flattened; aperture elongated, angular and channelled at the base, within whitish.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .52, Length 1.28 of an inch.

Remarks.—A fine, large, symmetrical species, furnished with a row of closely set tubercles on the middle of the whorl, and several irregular transverse striæ disposed to be tuberculate. The seven or eight specimens before me are very similar, differing but little in form or colour. The oldest one is rather browner. It is remarkable for its regular pyramidal form. The aperture is contracted, and rather more than one-third the length of the shell. I have great pleasure in dedicating it to Dr. Foreman, to whose kindness I owe the specimen in my cabinet.

Melania torquata.

Testâ tuberculatâ, subfusiformi, nitidâ, subtenui, luteâ; spirâ subelevatâ; suturis impressis; anfractibus septenis, subconvexis; aperturâ productâ, ad basim angulatâ, intus albida.

Shell tuberculate, subfusiform, shining, rather thin, yellow; spire rather elevated; sutures impressed; whorls seven, somewhat convex; aperture elongated, angular at the base, within whitish.

Hab. Tennessee. E. Foreman, M. D. My Cabinet. Diam. .42, Length .80 of an inch.

Remarks.—This is a very beautiful species, of which I have only one specimen before me. The necklace-like row, (hence its name,) of small closely set tubercles, gives it an attractive appearance. Each successive whorl covers up these tubercles as well as several striæ below them, leaving the whole spire smooth. The aperture is rather contracted, and nearly half the length of the shell. The outer lip is sharp, and very much curved. It has some resemblance to *M. alveare,* (Con.) but is a larger shell, less solid, and more fusiform.

Melania producta.

Testâ plicatâ, subfusiformi, subtenui, corneâ; spirâ obtuso-conicâ; suturis impressis; anfractibus octonis, planulatis; aperturâ ellipticâ, albidâ.

Shell folded, subfusiform, rather thin, horn-coloured; spire obtusely conical; sutures impressed; whorls eight, flattened; aperture elliptical, whitish.

Hab. Tennessee. E. Foreman, M. D. My Cabinet, and Cabinet of Dr. Foreman. Diam. .57, Length .70 of an inch.

Remarks.—This species has rather distant folds on the first six whorls, and a disposition to tuberculation on the middle of the lower whorl, the superior part being disposed to be striate. The base of the columella is twisted, and the channel well impressed. The aperture is quite one-half the length of the shell.

Melania curvata.

Testâ obtuso-carinatâ, subpyramidatâ, subcrassâ, tenebroso-corneâ; spirâ subelevatâ; suturis impressis; anfractibus octonis, convexis; aperturâ parvâ, curvatâ, albidâ.

Shell obtusely carinate, somewhat pyramidal, rather thick, dark horn colour; spire somewhat elevated; sutures impressed; whorls eight, convex; aperture small, curved, whitish.

Hab. Tennessee. E. Foreman, M. D. My Cabinet, and Cabinet of Dr. Foreman. Diam. .40, Length .73 of an inch.

Remarks.—The two specimens before me vary very little in all their characters. This is a very distinct species, resembling more, perhaps, *M. conica* (Say) than any other. The whorls are close, and about the middle are placed two or three obscure carinæ, which cause a slightly impressed channel. The aperture is small, being a little more than one-third the length of the shell. The outer lip is sharp and very much curved, causing the base of the columella to be twisted. In one of the specimens an obscure band near the base in the interior may be observed.

Melania expansa.

Testâ lævi, subfusiformi, subcrassâ, luteolâ; spirâ obtuso-conicâ; suturis subimpressis; anfractibus quinis, subconvexis; aperturâ magnâ, expansâ, albidâ.

Shell smooth, somewhat fusiform, rather thick, yellowish; spire obtusely conical; sutures somewhat impressed; whorls five, slightly convex; aperture large, expanded, whitish.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .43, Length .63 of an inch.

Remarks.—A solitary specimen of this was among the shells sent by Dr. Foreman. In form it resembles *M. variabilis*, (nobis,) but may be distinguished from that species in being larger, and having a larger proportionate aperture, which is more expanded. The aperture is full one-half the length of the shell. The specimen under examination has four bands, and the yellow epidermis is nearly covered with a deposite of the oxide of iron.

Anculosa incisa.

Testâ lævi, ovato-gibbosâ, crassâ, luteo-fuscâ; spirâ brevis; anfractibus quaternis, planulatis; columellâ supernè incrassatâ; aperturâ magnâ, ovatâ, albâ.

Shell smooth, ovately gibbous, thick, yellowish brown; spire short; whorls four, flattened; columella thickened above; aperture large, ovate, white.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinets of Dr. Foreman, T. G. Lea, and J. Clark. Diam. .44, Length .64 of an inch.

Remarks.—Four individuals of this species are before me, and all of them have, though in a less degree, the remarkable pleurotomose character, described in the remarks on *Melania excisa*, page 25.

The observations there made in regard to the genus, may in part be referred to for this shell. It might be supposed, that this cut could be caused by a fracture in the shell, or injury to the animal. But this is by no means the case. On the contrary, in one of the individuals where a fracture took place by the breaking off of the middle of the lip, this was subsequently replaced, and the curved edge reinstated as before. This species resembles in form *Anculosa Foremani*, herein described; but the spire is more exserted. All the four specimens have three brown bands more or less distinct, and the callus on the superior part of the columella is slightly maculate with brown. The aperture is about two-thirds the length of the shell.

Anculosa Foremani.

Testâ lævi, ovato-gibbosâ, crassâ, luteâ, transversè lineatâ; spirâ brevissimâ; suturis impressis; anfractibus subplanulatis; columellâ percrassâ, aperturâ submagnâ, ellipticâ, albidâ.

Shell smooth, ovately gibbous, thick, yellow, transversely lined; spire very short; sutures impressed; whorls somewhat flattened; columella very thick; aperture rather large, elliptical, whitish.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinet of Dr. Foreman. Diam. .40, Length .50 of an inch.

Remarks.—Two of the three specimens under examination have very distinct, capillary, revolving, deep brown lines between the top of the aperture and the base. Above that the space is nearly filled up with two indistinct, interrupted lines which give a clouded appearance to that portion of the shell. The third specimen is of a brighter yellow with all the lines nearly obliterated. In form this species very closely resembles *An. flammata* herein described, but the capillary lines distinguish it at once, and the columella is thicker at the base. In all the three specimens a slight tinge of brown may be distinguished on the middle of the columella. I dedicate the species to Dr. Foreman, who kindly placed a specimen in my cabinet.

Anculosa solida.

Testâ lævi, ellipticâ, subcrassâ, luteo-fuscâ; spirâ exsertâ; suturis impressis; anfractibus planulatis; columellâ incurvatâ, supernè et infernè incrassatâ; aperturâ elongatâ, ellipticâ, albâ.

Shell smooth, elliptical, rather thick, yellowish brown; spire somewhat drawn out; sutures impressed; whorls flattened; columella incurved, thickened above and below; aperture elongated, elliptical, white.

Hab. Alabama. E. Foreman, M. D. My Cabinet, and Cabinet of Dr. Foreman. Diam. .38, Length .60 of an inch.

Remarks.—Three specimens only were sent to me by Dr. Foreman. They differ very little from each other, except that one exhibits a few indistinct elevated revolving striæ. Other specimens may present this character more strongly. Neither of the specimens have a perfect spire, the apices being eroded. The number of whorls I should think, however, were five. The aperture seems to be rather more than half the length of the shell. The columella is remarkable for its callus near the base as well as having another above.

Anculosa flammata.

Testâ lævi, ovato-gibbosâ, crassâ, luteolâ, obliquè flammatâ; spirâ brevissimâ; suturis impressis; anfractibus subplanulatis; columellâ supernè percrassâ; aperturâ submagnâ, ellipticâ, albidâ.

Shell smooth, ovately gibbous, thick, yellowish, obliquely flammulate; spire very short; sutures impressed; whorls somewhat flattened; columella very thick above; aperture rather large, elliptical, whitish.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .38, Length .49 of an inch.

Remarks.—A single specimen, broken on the outer lip, is before me. The middle of the whorl is slightly flattened. The spire is eroded, and little more than one whorl is presented. The epidermis on this part is nearly perfect, and exhibits a fine yellow ground with thickly set, oblique, flammulate, brown bands. This species is very distinct from any I know, not being aware that flammulate bands have been before observed in any of this genus. In a single species of *Melania*, somewhat similar bands exist, the *M. breviformis* (Pareyss,) from New Holland.

Paludina incrassata.

Testâ lævi, ellipticâ, subtenui, imperforatâ, tenebroso-corneâ; suturis subimpressis; anfractibus subconvexis; columellâ supernè incrassatâ; aperturâ subrotundatâ, parvâ, intus cæruleâ.

Shell smooth, elliptical, rather thin, imperforate, dark horn colour; sutures somewhat impressed; whorls somewhat convex; columella thickened above; aperture rather round, small, within bluish.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .52, Length . . . of an inch.

Remarks.—Rather more than the first whorl only of the specimen before me is perfect, and I would not have proposed it for a new species, but that this part differs from any which has come under my notice. The callus on the superior part of the columella is very like that we find in the genus *Anculosa*. The aperture is smaller than usual in this genus. The upper whorls being decollate, neither their number nor the form of the spire can be given.

Paludina coarctata.

Testâ lævi, ovatâ, coarctatâ, crassâ, imperforatâ, olivaceâ; spirâ exsertâ; suturis valdè impressis; anfractibus planulatis; aperturâ subparvâ, ovatâ, albâ.

Shell smooth, ovate, compressed, thick, imperforate, olive colour; spire drawn out; sutures much impressed; whorls flattened; aperture rather small, ovate, white.

Hab. Alabama. E. Foreman, M. D. Cabinet of Dr. Foreman. Diam. .50, Length .98 of an inch.

Remarks.—This species, of which a single specimen only was received, differs from all of the genus which has come under my notice. It is remarkable for its compressed form, the body whorl being quite flattened. The apex is eroded, which prevents the number of whorls being ascertained: there appear to be five. The aperture is less round than usual in this genus, and may be rather more than half the length of the shell.

SYSTEMATIC INDEX.

	Page		Page		Page
Helix minutissima,	17	Lymnæa fusiformis,	10	Melania robusta,	19
" Mobiliana,	17	" Griffithiana	8	" torquata,	27
" Tennessensis,	1	" Kirtlandiana,	12	" turgida,	18
Carocolla Edgariana,	2	" Nuttalliana,	9	" Vanuxemiana,	25
Bulimus Jayanus,	2	" parva,	11	Valvata bicarinata,	21
Achatina striata,	3	" Philadelphica,	8	Paludina angulata,	22
" turbinata,	2	" planulata,	9	" coarctata,	30
Succinea aurea,	4	" plica,	10	" Coosaensis,	23
" Candèana,	5	" rubella,	12	" cyclostomatiformis,	23
" fulgens,	5	" rustica,	10	" incrassata,	30
" gracilis,	3	" strigosa,	12	" obtusa,	13
" inflata,	5	Melania brevis,	26	" regularis,	13
" Nuttalliana,	4	" curvata,	28	" Troostiana,	14
" Oregonensis,	5	" excisa,	25	Anculosa carinata,	15
" Totteniana,	4	" expansa,	28	" flammata,	30
" Wardiana,	3	" Foremani,	27	" Foremani,	29
Planorbis bellus,	6	" glabra,	18	" gibbosa,	15
" Buchanensis,	6	" Haysiana,	25	" Griffithiana,	20
" regularis,	6	" impressa,	19	" incisa,	28
Physa Hildrethiana,	7	" Jayana,	20	" rubiginosa,	20
" inflata,	7	" oliva,	27	" solida,	29
" Troostiana,	7	" Ordiana,	26	" Troostiana,	15
Lymnæa bulimoides,	9	" ovalis,	25	" tuberculata,	21
" casta,	11	" perfusca,	18	" variabilis,	15
" coarctata,	11	" picta,	19	Amnicola orbiculata,	16
" curta,	11	" producta,	28	" parva,	16
" exigua,	9			Io tenebrosa,	17

ARTICLE II.

*Account of a Trigonometrical Survey of Massachusetts, by Simeon Borden, Esq., with a Comparison of its Results with those obtained from Astronomical Observations, by Robert Treat Paine, Esq., communicated by Mr. Borden. Read 16th April, 1841.**

Before entering upon the details of the Massachusetts Survey, and Map, I propose to give you a few particulars respecting the history of its origin and progress.

SECTION I.—HISTORICAL PARTICULARS RELATIVE TO THE SURVEY OF MASSACHUSETTS.

The legislature of Massachusetts passed resolves on the first of March, 1830, requiring the City of Boston and the several towns in the Commonwealth to make an accurate map, each of its own territory, upon a scale of one hundred rods to an inch, and deposite the same with the Secretary of State. These resolves go much into detail upon the subject. On the third of the same month, a resolve was passed authorizing the Governor to appoint a skilful surveyor to make a survey of the state upon trigonometrical principles, combining astronomical observations therewith.

Some time in the following summer, the Governor appointed Robert Treat Paine, Esq., as principal Engineer, with James Stevens, Esq., of Newport, Rhode Island, for his principal assistant. During the latter part of the season Mr. Stevens visited Washington, and borrowed a number of instruments from the general government. He also called upon me to make him an apparatus for measuring a base line. In the fall he selected a location for a base line and partially traced it. This, I think, is all that was done in 1830. Mr. Paine, I believe, ordered some instruments which he received the following season. In the course of the ensuing winter I made the measuring apparatus, and made the necessary repairs in the instruments which Mr. Stevens had procured at Washington. Toward the latter end of April or first of May, 1831, Mr. Stevens had all his apparatus transported to the base line: and some time in June I joined him to assist in the measurement. Mr. Paine was considered at this time as the principal engineer; but as he had not taken any part in the field operations in which Mr. Stevens had been engaged, nor given him any directions, Governor Lincoln ordered Mr. Stevens to report directly to him, which

* It is proper to mention that this paper was not originally intended for the Transactions, but formed part of a correspondence between the author and Sears C. Walker, Esq.

he ever afterwards did; and thus, in effect, Mr. Paine became the astronomical, and Mr. Stevens the topographical surveyor.

Mr. Paine, I think, in the course of this season, commenced making astronomical and chronometrical observations.

When we had completed the measurement of the base line, I left the service; but I again engaged, as an assistant to Mr. Stevens, the following spring, and have been ever since connected with the survey. After Mr. Stevens had conducted the topographical survey about three years, he resigned his appointment. As I had assisted him in every part of the work which had been performed, and of course was fully acquainted with all that had been done, the governor thought it proper to place the survey under my charge. The field work of the survey I completed in the spring of 1838; and I presumed that when I had made the necessary trigonometrical computations, my labours would end; or that, if I were continued, it would be in the capacity of an assistant to Mr. Paine, since I supposed that Mr. Paine would at this point take charge of the construction of the map, and particularly of the mathematical calculations necessary to render the work complete. In this, however, I was mistaken, for Mr. Paine had made his final report a short time before the triangulation was in readiness for the commencement of compiling the map; and thus the responsibility of completing the work unexpectedly devolved upon me.

After I had completed the field work, and had calculated a sufficient number of the main triangles to cover a section of fifty miles square of the western portion of the state, I commenced the work of compiling the map, when I found the town maps which had been returned to the Secretary so incorrectly drawn as to render it impossible, in their actual state, to make a satisfactory map from them. I was then obliged to go into the field again, with four or five assistants, and make corrections; and this operation has been one of continued perplexity, and has cost the state, in my department alone, at the least estimation, ten thousand dollars more than it would have done, had the towns executed their portion of the work in good faith. It is my opinion that had the work been performed from beginning to end under the direction of a faithful and competent engineer, it might have been executed, at the rate of compensation which has been paid, for many thousand dollars less than it has now cost.

Still the survey of the state of Massachusetts, including eight thousand two hundred and thirty square miles of territory, and having an indented sea coast of about three hundred miles, has been completed, in little more than ten years, at an expense of only sixty-one thousand, three hundred and twenty-two dollars. A brief and imperfect account of this work is offered in the present paper. Of its merits and the manner in which we have executed the trust committed to our charge, we leave others to judge.

SECTION II.—OF THE STANDARD SCALE AND APPARATUS FOR MEASURING THE BASE.

The standard of length first selected was a scale of two feet, constructed upon compensating principles, and of course unsuitable for subdivision. Being afterwards compared at Washington, by Mr. Hassler, Superintendent of the United States' Coast Survey, with his 82 inch scale of Troughton's construction, which is an exact copy from the well known Troughton scale of Sir George Shuckburgh, it was found to be 0.0018 inches too short, at the temperature of 57°.5 Fah. But a part of the triangles having been, previous

to this comparison, computed according to the Massachusetts scale, it was thought best to complete the calculations in the same manner, and make correction afterwards, when the proper standard should be fixed upon. For this standard, Hassler's 82 inch Troughton, at the temperature 62° Fahr., was chosen.

The apparatus with which the base was measured was constructed upon compensating principles, and was supported with a strong and firmly soldered tin tube between seven and eight inches in diameter, and, while in use, placed upon tressels properly contrived for carrying on such operations, a simple cross upon a plate of silver marking the terminus of the measure. The termination of each measure was observed with suitable compound microscopes, furnished with cross hairs, and supported upon stands conveniently contrived for such operations.

The base line chosen for the Massachusetts survey was on the Connecticut river, above Northampton, and was found to be 39009.73 feet, or 7.3882 miles long. In addition to the information concerning its location, I have concluded to furnish, in a tabulated form, a comparison of its two measurements; the line having been twice measured. The details are of course omitted. The termini of the base line were marked thus, ⊕, upon copper bolts of about three-fourths of an inch in diameter, which were driven firmly into holes drilled for the purpose in large stones, which were carefully imbedded in the earth about eighteen inches beneath the surface. The southern terminus of the base line is situated near the middle of a large field belonging to Josiah Ellis in the town of Hatfield, upon the west side of the Connecticut river. Its bearing and distance from the meeting-house in Hatfield village will probably be sufficiently well indicated by stating the latitude and longitude of each.

	Latitude.	Longitude.
Hatfield Church, - - - - - - - - - - - -	42° 22′ 10″ .97	72° 36′ 11″ .73
Southern terminus of base line, - - - - - -	42 22 21 .07	72 37 12 .67.

The northern terminus of the base line is situated in a lot of land upon the south bank of Bloody Brook, in the town of Deerfield. Its bearing and distance from the Bloody Brook meeting-house will be sufficiently well shown by comparing the latitudes and longitudes of each.

The latitude of Bloody Brook Church being	42°	.29′	.04″	.82	North.	Longitude	72°	.36′	.40″	.78 West.
" " Northern terminus of base line,	42	.28	.46	.44	"	"	72	.37	.05	.28 "

In measuring the base line we commenced from the north end; and at the end of every thousand feet we drove small plugs or piles of wood into the ground, and marked upon them, by means of a small brass wire driven into the top of each, the termination of every thousand feet, as nearly as we conveniently could, without consuming too much time. We also left marks at the terminus of each day's work. With such of these marks as we found undisturbed upon our second measurement, we compared our work.

I would observe, that in making up the list of those comparisons, where the first measurement exceeds the second, I have marked the differences thus, +; and where the second measurement exceeds the first I have marked the differences thus, —. The comparisons are shown in the following table.

Number of the comparison.	Length of first measure.	Length of second measure.	First difference.	Second difference.
1	11995.225	11995.450	— 0.225	.225
2	23994.307	23994.413	— 0.106	.119
3	35991.383	35991.772	— 0.389	.283
4	47991.350	47991.638	— 0.288	.101
5	59991.266	59991.554	— 0.288	.000
6	71991.325	71991.444	— 0.119	.169
7	95981,617	95981.886	— 0.269	.150
8	107981.560	107981.665	— 0.105	.164
9	119981.242	119981.552	— 0.310	.205
10	131980.062	131980.360	— 0.298	.012
11	143979.732	143980.046	— 0.314	.016
12	155974.794	155975.128	— 0.334	.020
13	167970.783	167971.008	— 0.225	.109
14	179962.639	179962.938	— 0.299	.074
15	203961.267	203961.493	— 0.226	.073
16	227960.220	227960.355	— 0.135	.091
17	251960.280	251960.300	— 0.020	.115
18	287960.554	287960.276	+ 0.278	.258
19	299960.660	299960.261	+ 0.399	.121
20	311960.715	311960.261	+ 0.454	.055
21	347959.994	347959.461	+ 0.533	.079
22	371959.892	371959.182	+ 0.710	.177
23	386337.443	386336.615	+ 0.828	.118
24	428915.406	428915.268	+ 0.138	.690
25	467914.561	467914.324	+ 0.237	.099
		Total sum of all the differences, in inches,		3.523

I would here remark, that our apparatus having been constructed upon principles entirely new, so far as it respects an application to works of this kind, we found considerable trouble in our first attempts at measuring, and it was not until we had measured that portion of the line represented by the column marked "first measure," beginning at the bottom, or No. 25, and extending as far as Nos. 19, or 18, or thereabouts, that we had perfected all the adjustments of our apparatus. This portion of the line was, moreover, very uneven, or hilly, so that we were frequently obliged to measure over ridges upon inclinations of from 3 to $7\frac{1}{2}$ degrees. The combination of all these troubles and difficulties may account for the large errors apparent in that part of the measurement. Since we found less difficulty in measuring after we had perfected our apparatus, it is reasonable to suppose that the second column gives the most accurate measurement: but as the final results were so near alike, I have given equal weight to both.

The above table contains the length of that portion of the base line which was measured with the fifty feet apparatus, to which is to be added 265.466 inches, which were taken with the beam compass. Before making the addition, I would observe that the exact length of the fifty feet measure, as determined by the Massachusetts standard after the measurement of the line was completed, was found to be only 599.998 inches.

Therefore, a mean of the measures exhibited in the table, reduced to Massachusetts standard, is equal to	467,912.882	inches.
Add for the measure taken with the beam compass, ...	265.466	"
Whole length of base line, ...	468,178.348	

Which being further reduced to Mr. Hassler's standard at 62° of Fahrenheit, and to the level of the sea, gives the final adopted length at 39009.73 feet, or 7.388 miles.

The heights of the north and south ends of the base line, above the mean level of the sea, were determined in the same manner as those of the other stations to be mentioned hereafter. At the time of measuring the base, however, we found its north end to be 49.55 feet higher than the south by the following process, namely: For the purpose of measuring the line accurately and conveniently, we divided it into a series of hypothenuses upon which the measuring apparatus was carried; the inclination of these hypothenuses was determined by precise measures of the depression or elevation of each; and the difference in the height of their termini was then computed. The coincidence of the difference of level found by the two independent methods serves to test the precision of both. Thus the height of the north end of the base above the mean level of the sea was found by vertical triangulation to be 220.02 feet, and of the south end by a similar process 169.59 feet; the difference being 50.43 feet, which differs only 0.88 feet from that obtained by inclination of the hypothenuses.

For measuring the base line eight persons were employed. This number, which included the principal and assistants, was found necessary to perform the work dexterously. Three small tents were used for covering the microscopes when necessary.

SECT. III.—OF THE TRIANGULATION, AND THE PREPARATION OF THE MAP OF MASSACHUSETTS.

The instrument used in measuring horizontal angles was a twelve-inch repeating Theodolite, made by Troughton for Mr. Hassler at the commencement of the coast survey, and fully described in the second series of the Transactions of the American Philosophical Society, published at Philadelphia in 1825, page 328. I would refer to that paper for a description of it, and will merely add, that I found it necessary to supply the instrument with a firmer clamping apparatus, and with a more powerful telescope to be used in measuring the azimuth angles. This telescope was forty-six inches in focal length. It is now in the hands of Major Graham, upon the north-eastern boundary survey.

The vertical angles were measured with the small telescope and vertical circle which Mr. Troughton made for the instrument, it being difficult to attach the vertical circle to the arbour of the large telescope. The clamps of the vertical circle were also insufficient for repeating the measures of angles of much magnitude; but as our vertical angles were for the most part very small, I did not make any change or addition to its clamping apparatus.

After the work fell into my hands, our party never consisted, principal and assistants, of more than three persons, while we were employed in making the triangulation; with the exception, however, of occasionally employing a person a few hours to assist us in putting up a heavy signal, and sometimes for a day or so to assist in felling trees which obstructed our operations.

We had one circular tent, about nine feet in diameter at the upper end of the main body, which is about six and a half feet from the ground, and much larger at the lower end. The roof or top of this tent was in the form of an obtuse cone, and the sides or walls were of four separate curtains, with suitable strings for closing them when

necessary. This tent was employed to protect the theodolite, when in use, from the effects of the sun and wind, and at other times from the weather.

The state of Massachusetts is so densely settled, that we could without much inconvenience find lodgings with the inhabitants near almost all of our stations; so that we did not provide ourselves with camp equipage. When we found it necessary to encamp at a station, we built up small cabins, which we covered with brushwood and turf. We were only obliged to encamp regularly at three stations.

For the greater portion of the time, while we were triangulating the state, we were provided with two horses, and with a spring wagon made particularly for the service, and of rather large dimensions, for the convenience of stowing our instruments and baggage. While the survey was under the direction of Mr. Stevens, and after the base line was measured, an additional horse and a small buggy were provided for his accommodation.

The time occupied at a station, in measuring angles, varied from one day to twenty-five, depending much upon the state of the weather, and the amount of labour to be performed. I suppose that the average time spent at stations of much magnitude would be from five to ten days. Had we been provided with an instrument of suitable dimensions* and properly constructed, more than a third of the time occupied in measuring angles might have been saved.

At the commencement of the survey, it became an object of much interest, to contrive a signal which it would be convenient to erect in almost every situation imaginable; which would be firm and secure when erected, at least so far as regards high winds and storms; which would admit of being easily adjusted, repaired, or altered when found necessary; which would furnish a convenient support for our tent, and at the same time allow the theodolite, without an inconvenient derangement, to be placed directly over the centre of the station. The signal which we then contrived, and afterward used through the whole survey, is supposed to possess all of the properties named above, in a very satisfactory degree. The dimensions of the signals vary somewhat on account of the different condition or situation of the sites or stations over which they are erected, and not unfrequently have we been obliged to accommodate them to the size of the timber near at hand. The signal staffs were from fifteen feet to eighty feet in height. When we have had occasion to erect a very high signal, we have found it necessary, for the purpose of securing the top, which in these cases is the only portion used, from being swayed by the wind, to attach four slender wire guys or stays, which may be secured to pins driven into the ground for the purpose, or to trees or other objects, at hand. Lines would not make suitable stays, on account of their liability to lengthen and shorten with slight variations of moisture.

The following figures or sketches are intended to represent the signal in all its various attitudes or positions. Fig. 1 represents the signal as framed or put together upon the ground previous to erecting it;—a, a, a, represent the braces or legs which support the signal staff b, when it is erect; c represents a bulb or balloon, (as we frequently call it,) of common cotton or any other cheap white cloth, to render the signal more conspicuous under certain degrees and conditions of the light. It is formed by sewing together some pieces of cloth into the size or diameter of a flour barrel and about a yard and a half long. Two flour barrel hoops are then placed within the bag, equidistant from its end, and secured

Fig. 1.

* The instrument should be as large as can be conveniently transported.

there by sewing the bag firmly to them. Their distance apart should be from a half to three-fourths of a yard. The cloth thus prepared is firmly secured to the upper end of the signal staff, by puckering the ends of the bag, and sewing them to it with strong twine; taking care so to arrange the ends as to cause them to support the signal bulb or balloon concentrically with the signal staff. We have sometimes bored a hole into the top of the signal staff and inserted therein a tuft of pine or other dark-coloured boughs,—a dark-coloured signal being frequently more conspicuous than a light-coloured one.

The materials which compose the signal frame are frequently procured from the nearest forest trees; and are put together without any other dressing or preparation than merely depriving them of their branches, and fashioning their ends in a suitable manner to unite them into a firm and compact frame or tripod. The frame is secured by passing through the upper end of the braces and through a point near the middle of the signal staff a strong wooden pin or an iron bolt. The whole will be sufficiently apparent from an inspection of the figures, without further description. The signal thus described, so far as my experience goes, has been found to answer well in all situations. It is readily and easily adjusted upon bare smooth rocks,—that is, as bare and as smooth as they are ever found in their natural position. I have placed them in soft swampy lands, and have found them to stand in those situations a long time without any perceptible derangement.

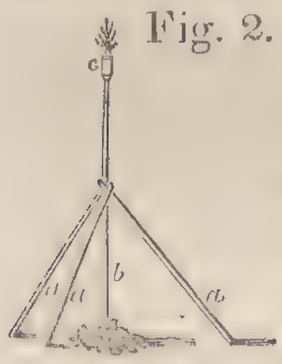


Fig. 2.

Fig. 2. represents a signal erected, and in suitable adjustment to be observed from other stations for the purpose of measuring angles therewith.

I would here state that, as by far the greater portion of the primitive trigonometrical stations in Massachusetts are situated upon the tops of hills and mountains whose summits are bare rocks, or rocks very slightly covered, here and there, with earth, we have marked these points by drilling a small hole about two inches deep into the rocks, and inserting therein a small copper bolt marked thus, ⊗; and after having put our signal frame together, with the aid of a small tackle,—a derrick staff (as it is called in the language of seamen) secured in its vertical position with guy ropes or stays,—the signal is readily erected over the bolt, and that part of the signal staff which extends upwards from the meeting of the braces adjusted perpendicularly over the centre of the bolt. For determining when the signal was in proper adjustment, we used two small telescopes mounted very similarly to a transit telescope. These instruments, when placed in such a manner that the vertical planes of their motion, when passing through the centre of the upper bolt, would intersect each other nearly at right angles, would readily show, when pointed to any part of the signal staff, whether it was or was not in proper adjustment. By a movement of the lower ends of the braces, which is very easily performed, the whole of the signal frame can be moved in any direction desired. Having put the main body of the signal frame in its proper situation, the upper end of the signal staff may be rendered plumb by moving the lower end in an opposite direction. The lower end of the signal staff comes very near the ground, but should not be allowed to touch it, and when it has obtained its proper place, the lower end is secured, and that of course secures also the upper end, by piling a heap of small stones about it, if they can be found near at hand; or, when they cannot, by throwing about it a small mound of earth. Many signals of the kind described, which I erected at the commencement of the survey, were standing two years

ago without any apparent derangement, and I presume will continue to stand and retain their adjustment until they decay. Before I dismiss this subject I would further mention, that whenever our stations happened to be situated where rocks were not to be found, as upon Cape Cod, Nantucket, &c., we marked the stations by burying a bottle about eighteen inches beneath the surface, first filling it with sand, so that it should not collapse if it should happen to be broken.

Fig. 3.

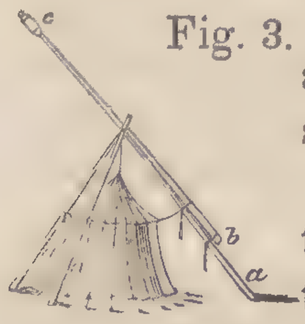
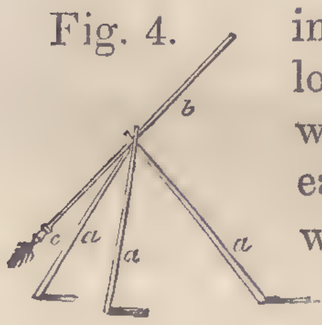


Fig. 3. Shows the position of the signal while we are measuring angles at the station. A sketch of the tent which protects the theodolite, is seen suspended from the frame.

Fig. 4. Shows the position of the signal when we put new cloth or a tuft of pine or other species of boughs upon it, or make any repairs, additions or alterations connected with the top of the signal staff.

When the signal frames have been light or slender, we have bored holes into the lower ends of the braces and inserted strong pins, which we have loaded with stones to prevent the wind from blowing them down. And where stones were not to be found, we have driven strong pins into the earth, near the ends of the braces, and nearly at right angles therewith, which we have nailed firmly to the frame.

Fig. 4.



Respecting atmospheric phenomena, I would state that I have rarely been able to measure angles with a satisfactory degree of accuracy, whenever objects appeared in a striking degree looming up, as the sailors call it. These loomings or mirages are frequently seen, particularly upon the sea coast. I have often seen portions of the tops of mountains, valleys, trees, and houses double, that is, one above another. Sometimes I have seen objects triple, but I have never seen their images inverted. My experience shows that objects are refracted side-ways during extraordinary mirages; and I am very confident that they are frequently laterally refracted when there is no apparent mirage.

As respects the transparency of the atmosphere, or more correctly speaking that state of the atmosphere which permits distant objects to be distinctly seen, I have made many observations, with the view of ascertaining the reason why distant objects cannot be distinctly seen on certain days when the atmosphere appears to be uncommonly transparent. As I am not aware that any person has published an account of this apparent paradox, I will endeavour to state my experience upon this subject in as brief a manner as I well can. Hints of this kind may prompt others to investigate the subject; and whether my theory be found true or false, will be of little importance, provided the real cause be discovered, and we be enabled to predict correctly the state of the atmosphere, with respect to seeing distant objects distinctly. To the engineer engaged in trigonometrical operations this knowledge will be of great value, as it may save him the trouble of much useless and vexatious labour. It may also be useful at times to those engineers who have never been engaged in very extensive surveys, and of course can know but little from their own experience of the different states of the atmosphere; particularly when they have occasion to run a line of considerable extent, or wish to observe very distant objects. The curious traveller might also add much to his gratification, could he be

able to form a correct opinion of the condition of the atmosphere, favourable for viewing distant objects.

At the latter end of the month of November, 1835, I was at the trigonometrical station in Fairhaven endeavouring to measure the angles which were deemed necessary from that station. Soon after our arrival, we had a fall of snow which covered the ground several inches thick. Severely cold weather succeeded it; and although the atmosphere appeared uncommonly transparent to the unassisted eye, still we were unable to see our distant signals, particularly those upon Martha's Vineyard, and the Elizabeth Islands. The line of sight to these signals lay across the waters of Buzzard's Bay, and the Vineyard Sound. In a few days after the snow had fallen, the weather became warmer, and a rain ensued, which took off nearly all the snow. On the morning following the rain, namely, the fifth of December, we went early to the station, and discovered that all of our signals could be seen with tolerable distinctness, although the atmosphere was apparently not near so transparent as it had been at several of our previous visits to the station. The heavens were densely clouded. I think the sun did not appear at all, or if seen it must have been so very dimly as not to have perceptible influence upon the atmosphere. The day of course was, comparatively speaking, a dark one.

We commenced our operations of measuring angles as rapidly as we could; but we had not been long engaged in our work before the atmosphere began to present a very curdled appearance, and our signals to appear dim. In a short time they appeared plainer again, and then again more dim: the appearances thus alternating. Having a thermometer at hand, I directed Mr. Read, one of my assistants, to observe that instrument, and see if any changes took place in it corresponding with the changes in the appearance of the signals; and we soon ascertained that these changes always occurred together. The day was a very remarkable one for our operations, which we were enabled to prosecute without intermission until we had completed all we desired at the stations; and from the time we first commenced observing the thermometer until our work had ended, a slight change of the instrument could be easily detected from the appearance of the signals, particularly when looking across water. I think the change of appearance was not so strikingly apparent across the land. Having made these observations, I endeavoured to estimate the temperature of the surface of the land and water across which our observations were made. The sun not having shone at all, or at most not sufficiently bright to have any perceptible effect during the time of our observations, the surface of the earth might be considered of a uniform temperature. It was frozen, and the preceding night had been warm and rainy; and I therefore concluded that the surface of the earth must be at or near a freezing temperature, namely, 32° of Fah. The water, of course, must have been several degrees warmer. Still it was very cold; for a few days previous, we had had a considerable fall of snow, which, as is well known, chills water very rapidly. The weather which succeeded the snow storm had been extremely cold. I did not make any memoranda at the time, or if I did I cannot now find them, but I presume the thermometer must have stood as low as 10° or 12°, until within twelve or fifteen hours before the observations were made. The waters of Buzzard's Bay and the Vineyard Sound are very shallow, and ebb and flow very little; of course the waters could receive but a slight influence from the warm

water of the deep ocean in the course of a few hours.* The probability therefore is, that the surface of the water could not have been many degrees above freezing; and I suppose it must have been as low as 40°, if not lower. The thermometer at the station, I find, by my memoranda, stood generally at 34°, and did not vacillate more than two degrees. The surface of the earth, as before stated, is supposed to have been of the temperature of 32°. These numbers will show that there was a very near agreement between the temperature of the air, and the temperature of the surface across which the observations were made. I came therefore to the conclusion that the nearer the atmosphere and the surface of the earth or water across which the line of sight lies are to the same temperature, the more distinctly can distant objects be seen in an atmosphere of equal transparency. Since the morning on which these observations were made, I have observed many phenomena, natural and artificial, which might be cited in corroboration of the above conclusion; and I have seldom seen any thing to disprove it.

Before we finally dismiss this subject it may be well to describe, by way of elucidation, the different appearances of distant objects, commencing our description at a time when the objects appear plain and distinct, and continuing the description through all the different grades of appearances until they have entirely faded away, or until they cannot be longer seen.

Before entering upon the description, I would premise, that the atmosphere is supposed to be transparent; that is, free from fogs, smoke, dust, or other heterogeneous matter.

In choosing a time to commence our observations, I have selected the morning, as it is not unusual that all the phenomena which I shall notice succeed each in the order of their description. We therefore commence in the morning of a favourable day. Let us then suppose that when the sun has risen sufficiently to illuminate the distant objects, they are seen distinctly. We have been led to the conclusion, that when distant objects are distinctly seen, the atmosphere and the surface over which our line of sight passes must be of the same temperature; and experience has shown us that soon after the sun rises, objects are generally more distinctly seen than at any other time of the day, previous to within an hour or two of the sun's setting. And our reason will teach us that the surface of the earth and the atmosphere are oftener of the same temperature, morning and evening, than at other times of the day; therefore there must then be less of ascending and descending currents in the atmosphere.

The objects at this time of the day (morning) appear perfectly still, and present a well defined and distinct outline. I have of course supposed them to be stationary. As the sun rises, the surface of the earth absorbs warmth more readily than the air, and of course the stratum of air which lies in immediate contact with the earth becomes rarefied and rises, forming ascending currents while the vacuum is supplied by descending currents. In consequence of this condition of the atmosphere, distant objects* present a waving appearance;—the light reflected from them appears to be sluggishly refracted from right to left and from left to right,—the image of the objects appearing of about the same dimensions as when first observed, and with still a distinct outline. The sun continues to rise:—the heat increases, and with it ascending and descending currents in the atmosphere;—the images of the objects lose their wavy appearance, and appear larger and fainter;—

* In support of this conclusion I would state the fact, that the ocean frequently freezes in the Vineyard Sound and at Nantucket, so extensively, that no water can be seen for many successive days.

the refractions from right to left and from left to right succeed each other with such rapidity that all further appearance of distinct outline disappears, and in proportion as their apparent size increases, their distinctness diminishes until, if the objects be small and far off, no traces of them can be seen.

If we suppose a diminution of heat, from the temperature of distinct sight, in the same ratio that we have been supposing an increase, (which frequently takes place in the afternoon of a cold day,) objects will present similar appearances and vanish in the same manner.

In the foregoing remarks, I have supposed the atmosphere to possess, during the time of observation, the same degree of transparency.

Respecting the process of determining the azimuths of the stations, I would state that the system adopted in preparing the work for the map, is the same we use in all our calculations. I shall therefore describe it in connexion therewith.

First, we divided the state into sections of about fifty miles square each, and determined the direction of meridians through the most central trigonometrical station in each section. Two of these meridians were determined by direct astronomical observations, and the other meridians were calculated. Angles were carefully measured from the two observed meridians with all the most conspicuous signals, which were in sight from the stations, (which we shall call for the sake of distinction *a*,) through which the meridians pass. The direction of the sides of the triangles radiating from the *a* stations were determined from the angles measured directly with the meridians. The azimuths of the sides of the triangles radiating from the stations seen from stations *a*, (which we shall call *b*,) were predicated upon the angles measured at the stations *b*, from the signals standing upon stations *a*. The azimuths of the sides of the triangles radiating from the stations seen from station *b*, (which we shall call *c*,) were determined from the angles measured at station *c*, from the signals standing upon stations *b;* and in like manner the same system was continued until we reached the extreme station of the section, or any desired station within the limits of the survey. The same system was carried forward between the two observed meridians, making each meridional station alternately station *a*. The difference in the azimuth determined by computing from a series of angles, from one meridional station to the other, with that determined from astronomical observations, gives the inclination of the meridians.

I would here remark, that carrying forward the computed azimuths upon this system, supposes that the meridians of the stations *a*, *b*, *c*, &c., are all parallel. I would further remark, that the azimuths of the sides of the triangles determined from the stations *a*, remain unaltered, for the reason that they have been carefully determined directly from the meridian, which must be considered of the highest possible authority, and they may for that reason be called standard lines. A line or side of a triangle extending from one station *b*, to another station *b*, is considered differently. Thus the azimuth of a line or side of a triangle extending from station *b*, No. 1, to station *b*, No. 2, (using the numbers merely for distinction's sake,) should be exactly the reverse of each other; that is, if the azimuths of the line determined from station *b*, No. 1, to station *b*, No. 2, is South 40° 10′ 20″ West, the azimuth of the same line, determined from station *b*, No. 2, should be North 40° 10′ 20″ East. But we will suppose that the azimuths do not exactly agree, (as it frequently

* I would wish to have it understood that the objects selected are slender poles, spires of churches, or something of the kind, because the reasoning will apply more readily to objects of that form.

happens;) that the azimuth of station, *b* No. 2, determined from station *b*, No. 1, is South 40° 10′ 22″ West, and the azimuth of station *b*, No. 1, determined from station *b*, No. 2 is North 40° 10′ 20″ East. As these are not exact reverse courses, a mean course is taken, and applied in the calculations as the azimuth of the line. Thus: 40° 10′ 22″ +40° 10′ 20″=80° 20′ 42″ and $\frac{80° .20′ .42″}{2}$ =40° 10′ 21″, which is taken as the bearing or azimuth from *b*, No. 1, to *b*, No. 2, reversing the names of the points as before explained: hence station *b*, No. 2, bears from *b*, No. 1, South 40° 10′ 21″ West, and *b*, No. 1, bears from *b*, No. 2, North 40° 10′ 21″ East. The same principle has been carried through the whole work. Having thus determined the azimuthal bearings of one station from another throughout the whole of a section, (the distances also from one station to the other, having been previously calculated according to the method of Legendre,) we proceed to make upon the principles of plane trigonometry, a table of Northings, Southings, Eastings, and Westings, as the case may require, of each station in the section, or any other station in the survey to which we desire to know the bearing and distance from station *a*, of the section. The whole calculated and summed up from station *a*, through which, as before stated, the true meridian passes. The station *a*, we shall therefore call the zero point. Then, with the Northing or Southing, Easting or Westing, of a point to which our table has been carried, (which in fact constitutes two sides or legs of a right angled triangle,) we calculate on the principles of plane trigonometry, the angle at the zero point, which gives the bearing or azimuth of the distant station from that point. And in a similar manner, the azimuth of any point within the scope of the table, may be determined from said zero point. To determine an azimuth or bearing from any other station than the zero point, it becomes necessary to calculate a meridian for that station, and for that purpose we must know the value of the meridional and perpendicular degrees. The method of managing these calculations will become apparent, when we show the method of determining the value of a degree perpendicular to the meridian, from the inclinations or convergence of two observed meridians. It will therefore be unnecessary to go further into an explanation of this subject in this place.

For the purpose of testing the accuracy of the main triangulation, I have made several double computations of the latitude and longitude of points situated in different parts of the state. In the first place, I computed the latitude and longitude of our primitive station, upon French's Hill, in the town of Peru, and upon the top of the Green Mountain ridge. I then computed the latitude and longitude of Tuft's Hill, from the French's Hill station, and also from the State House, which, if the triangulation had been accurately performed, and no mistake made in our calculations, should have both given the same position to the Hill. The table shows a discrepancy in latitude of 0″ .05=5 feet, and in longitude of 0″ .08=6 feet. This is not a greater error than might arise, in calculations of this kind, by using tables carried to only seven places of decimals; and, as I possessed no better tables, I could not make the computations with greater accuracy. The latitudes and longitudes of the other points given in the table were calculated, in a similar manner, from the stations named against them; and as the object of the table cannot be misunderstood, it will be unnecessary to give further explanations.

Names of Stations.	Where situated.	Latitude.	Longitude.	Names of points from which the computations emanated.
French's Hill	Peru	42° 25′ 30.″67.	73° 02′ 39.″27.	State House.
Tuft's Hill	New-Braintree	42 19 01. 87 42 19 01. 92	72 05 25. 00 72 05 24. 92	From French's Hill in Peru. " State House.
Mount Tom	Northampton	42 14 30. 97 42 14 30. 92	72 39 17. 10 72 39 17. 06	" French's Hill in Peru. " Tuft's Hill, N. Braintree.
Wachusetts Mount	Princeton	42 29 21. 23 42 29 21. 20	71 53 33. 88 71 53 33. 89	" State House. " French's Hill—Peru.
Highland Light	Cape Cod	42 02 23. 33 42 02 23. 39	70 03 55. 27 70 03 55. 43	" State House. " Hyannis—Barnstable.
Light House	Monomoy Point	41 33 34. 96 41 33 35. 00	69 59 56. 24 69 59 56. 24	" State House. " Hyannis—Barnstable.
South Tower	Nantucket	41 16 56. 59 41 16 56. 64	70 06 13. 91 70 06 13. 86	" State House. " Hyannis—Barnstable.
Court House	Barnstable	41 42 06. 08 41 42 06. 06	70 18 33. 80 70 18 33. 82	" State House. " Hyannis—Barnstable.
Wanomet Hill	Plymouth	41 55 38. 92 41 55 38. 85	70 35 44. 96 70 35 45. 03	" State House. " Hyannis—Barnstable.

It cannot be said that the table shows more than one unsatisfactory result, and that refers to Highland Light upon Cape Cod, as calculated from the State House and the Hyannis station. The greatest difference, which is in the longitude, amounts to 0″.16, or about 12 feet; in latitude, the difference is 0″.06,=six feet. I have looked over the triangles in that neighbourhood, and feel convinced that the extreme difference should not amount to more than five or six feet. I have therefore come to the conclusion that an error exists in the work of preparation to obtain the bearing and distance from the State House to Highland Light; but as it is an operation of considerable labour to go over the work again, and as the latitude and longitude will be given with sufficient accuracy for every practical purpose, I have thought I should not take the trouble to correct it.

SECTION IV.—OF THE VERTICAL TRIANGLES, AND THE LEVELLING OF THE PRIMITIVE STATIONS OF THE MASSACHUSETTS SURVEY.

I here present a table of the results and comparisons of the measurement of the heights of the primitive trigonometrical stations in the Massachusetts Survey, which Mr. Boutelle was preparing when he engaged as an assistant to Major Graham in making the North-Eastern Boundary Survey, and which he completed shortly afterwards. Mr. Boutelle's letter, and the accompanying map of the primitive triangles, will, it is hoped, furnish such a description of the progressive steps of the work, as may be readily comprehended by strangers to the local situation of our primitive triangles, and give a just idea of the operations and calculations.

The levels were gradually united one with another, as the calculations were made from the sea coast, until they reached Fay's Mountain. Having thought a table of the results of the levels as they were carried forward might be of interest, I have copied the one

which follows. The computations are illustrated in Mr. Boutelle's letter. The heights of the first five points were obtained by levelling directly from the middle point between high water and low water mark, in the ordinary manner of levelling for rail-roads and canals.

TABLE OF THE HEIGHTS OF THE PRINCIPAL POINTS AND STATIONS OF MASSACHUSETTS, ABOVE SEA LEVEL.

Names of Stations.	In what towns situated.	Heights in feet.
Bullock's Neck	On the State line at Seekonk	15.80
Nahant	Lynn	89.90
Coddon's Hill	Marblehead	117.75
Telegraph Hill	Marshfield	205.30
Hyannis Signal	Barnstable	81.42
Blue Hill	Milton	635.13
	Mean 635.05	634.97
Prospect Hill	Waltham	487.52
		479.67
	Mean 482.27	479.63
Prospect Hill	Hingham	243.23
Scituate Hill	Cohasset	186.13
		180.71
		177.14
	Mean 179.98	175.93
Monk's Hill	Kingstown	312.86
	Mean 312.93	313.00
Sprague's Hill	Bridgewater	193.54
		189.21
	Mean 192.26	194.03
Red Brush Hill	Wrentham	458.74
	Mean 455.86	452.98
Joe's Rock	Wrentham	484.64
	Mean 485.84	487.04
Beacon Pole Hill	Cumberland R. I.	515.19
	Mean 516.58	517.98
Fay's Mountain	Westborough	707.35
	Mean 706.87	706.39
Bald Hill	Douglass	710.57
		710.17
	Mean 713.56	719.94
Allum Pond Station	Douglass	777.31
		781.24
	Mean 777.61	776.27
Mount Daniel	Webster	785.31
	Mean 785.07	784.82
N. W. cor. of R. I.		633.22
Hatchet Hill	Connecti't line, Southbridge	1013.38
		1019.92
	Mean 1015.94	1014.54
Mugget Hill	Charleton	1017.63
		1008.92
	Mean 1011.62	1008 30
Hasnebumskit Hill	Paxton	1407.42
Wacushett Mount'n	Princeton	2013.00
		2022.63
	Mean 2022.02	2030.44

Names of Stations.	In what towns situated.	Heights in feet.
Chandler's Hill	Worcester	744.60
	Mean 748.37	752.14
Watatic Mt.	Ashburnham	1847.35
Castle Hill	Saugus	287.99
Holt's Hill	Andover	425.40
		420.51
		408.56
	Mean 422.95	422.94
Prospect Hill	Rowley	264.35
Ayer's Hill	Haverhill	344.29
		336.69
	Mean 339.23	336.71
Powow Hill	Salisbury	325.23
	Mean 328.02	330.81
Rail-cut Hill	Gloucester	204.21
		203.63
	Mean 204.68	206.20
Salisbury Marsh	State line, Salisbury	4.61
	* Mean 5.86	7.12
State House, (Top of Cupola.)	Boston	247.97
	Mean 248.84	249.71
Tuft's Hill	New Braintree	1185.45
		1173.47
	Mean 1179.30	1178.96
Hawe's Hill	Barre	1280.52
	Mean 1285.00	1289.49
Packard's Mountain	New Salem	1282.41
	Mean 1277.82	1273.24
Colonel's Mountain	Palmer	1166.45
		1173.95
	Mean 1171.67	1174.60
Mount Grace	Warwick	1631.35
	Mean 1628.21	1625.06
Bear Mountain	Wendell	1278.89
	Mean 1281.33	1283.78
Walnut Hill	Charlemont	1885.87
	Mean 1887.94	1890.02
More's Hill	Goshen	1713.08
High Ridge	Williamsburg	1479.88
French's Hill	Peru	2241.95
	Mean 2239.40	2236.85
Saddle Mountain	Adams	3506.16
	Mean 3505.50	3504.85

* This may be considered as a test station. It stands upon a rock, in the marsh, probably from one to two feet above high water;—the tide ebbs here about ten feet at an average.

Names of Stations.	In what towns situated.	Heights in feet.
Spruce Mountain	Adams	2587.83
	Mean 2588.38	2588.94
Jilson's Hill	State line, Rowe	2108.28
	Mean 2108.61	2108.94
Berlin Mt.	Berlin, N. Y. Taconic Mt's.	2813.11
	Mean 2814.35	2815.59
Clarksburg Mt.	Clarksburg	2272.34
Dug Hill	Blandford	1621.24
	Mean 1622.48	1623.72
Becket	Becket	2192.10
	Mean 2193.87	2195.65
Perry's Peak	Richmond	2084.26
		2093.47
	Mean 2089.01	2089.31
Jackson's Hill	Blandford	1716.71
	Mean 1717.21	1717.71
Seymour's Mount'n	Sandisfield	1699.00
	Mean 1698.05	1697.11
Bald Peak	Mount Washington	2623.66
		2622.49
	Mean 2623.65	2624.81
Winchell's Mount'n	Granville	1360.20
		1364.11
	Mean 1362.45	1363.03
Proven's Mountain	West-Springfield	666.77
	Mean 664.83	662.90
Mount Tom	Northampton	1214.01
		1215.61
		1211.69
		1212.34
	Mean 1213.63	1214.54
Hilliard's Knob	In line between Amherst and Granby	1123.71
		1119.21
		1118.84
		1116.76
	Mean 1119.74	1120.17
Rattlesnake Mt.	Connecticut line Wilbraham	1074.19
	Mean 1076.79.	1079.40
Peaked Mountain	Monson	1243.47
		1237.63
	Mean 1238.77	1235.21
Hitchcock's Hill	Wales	1190.91
	Mean 1189.64	1188.38
Mount Esther	Whately	993.63
	Mean 995.12	996.62

Names of Stations.	In what towns situated.	Heights in feet.
Mount Lincoln	Pelham	1246.30
		1244.57
	Mean 1245.92	1246.89
S. end of Base line	Hatfield	170.89
		170.67
	Mean 169.59	167.22
N. end of Base line	Deerfield	219.89
	Mean 220.02	220.13
The difference in the height of the termini of the base line determined at the time it was measured, is equal to 49.55 feet.		
Manomet Hill	Plymouth	392.04
	Mean 394.25	396.46
Alden's Hill	Middleboro	176.02
		176.16
	Mean 177.66	180.80
Baurn's Hill	Sandwich	297.27
Falmouth signal	Falmouth	192.78
Great Hill	Rochester	126.98
Mendal's Hill	Fairhaven	146.29
Copecut Hill	Fall-River	353.54
	Mean 355.00	356.47
N. Bedford Court House. Upper part of windows.	New Bedford	164.88
Rhode Island signal	Portsmouth R. I.	286.17
Pocasset Hill	Tiverton R. I.	323.26
Fall River signal	Fall River	258.53
	Mean 259.05	259.58
* Toweset station. Top of signal	Rhode Island line, Swanzey	28.88
College Hill	Providence R. I.	204.22
Great Rock Hill	Rehoboth	249.69
	Mean 247.77	245.86
Great Meadow Hill	Rehoboth	265.77
	Mean 265.54	265.31
King's Rock. Top sig. This signal was	State line, Swanzey probably 25 feet high	103.17
South end of verification Base	Seekonk	60.02
	Mean 57.39	54.77
German's Hill	Yarmouth	136.48
Mount Hope	Bristol R. I.	217.18
	Mean 216.41	215.75

I have thus given the results of our calculations of the heights of the hills and mountains in Massachusetts, following the straggling manner in which they succeeded each other, that a better judgment might be formed of the degree of confidence to be placed in the accuracy of the work. I would however mention, that when the calculations had been carried to Colonel's Mountain, in Palmer, they were extended from thence, in a northerly and westerly direction, to the extreme western part of the State, and thence, re-

* This may also be considered as a test signal. It stands near tide water, and although the height of the signal has never been exactly measured, yet I have no hesitation in saying, that the height we have found it to be cannot in the extreme differ from truth more than six or eight feet.

turning upon the southerly side of the State, again to Colonel's Mountain. We there compared them, by redetermining the height of the mountain from the returning levels, having traversed, in their zigzag course, a distance of several hundred miles. The result follows:—

Mean height of Colonel's Mountain, obtained from the levels carried directly from tide water,	1171.67 feet.	13.13 feet, difference.
From the return levels,	1184.80 feet.	

From the calculation of reciprocal observations, the mean refractions were found to vary from one-tenth to one-twentieth of the arc, upon the earth's surface, contained between the two stations from which the reciprocal observations had been made. It may be worthy of remark, that, in the western portion of the state, the refractions appeared to be much more regular than they were in the eastern,—rarely exceeding one-twelfth, or falling short of one-sixteenth of the contained arc. This phenomenon is probably owing to the trigonometrical stations being much more elevated, above the country which surrounds them, in the western portion of the State, than in the eastern. The western portions of the state may be said to be mountainous.

Probably I ought to mention, before I leave this subject, that the ascertaining of the heights of the trigonometrical stations was deemed of secondary importance; and, as a considerable portion of each day is unsuitable for making accurate observations, our general practice has been to measure the vertical angles at those times,—employing the more suitable states of the atmosphere for measuring the azimuthal angles. It is possible that mistakes may occasionally have been made in registering our field notes,—such as marking an angle as elevated when it should be depressed, and the contrary,—as we did not make repeated measurements of the vertical angles. These mistakes, however, can only take place when the two stations are near the same level. In other conditions, they can be corrected from a knowledge of the apparent or comparative height of the stations, at the time of calculating them.

The following description of the levelling operations has been drawn up, at my request, by Mr. Charles Boutelle, one of the assistants in the Massachusetts survey.

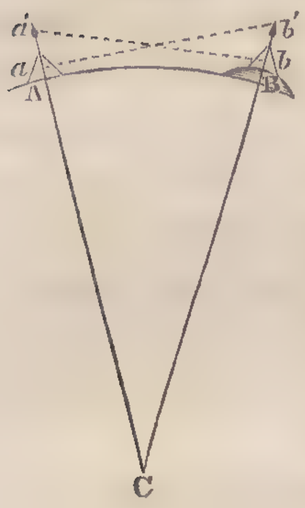
"In order to exhibit the whole matter, in relation to the chain of levels carried across this state in the course of the trigonometrical survey, I present herewith some farther statements and examples, illustrating the system pursued, and the modes of computation employed. I also send a map of the triangles, to show the relative positions of the points observed.

"The zenith distances were observed with the vertical repeating circle of the theodolite with which the azimuth angles were measured. It is graduated to 5″, and has four verniers. It was customary to make from six to eight repetitions, according to circumstances. Owing to a want of confidence in the accuracy of these observations in the early part of the survey, comparatively few observations were taken, and some stations, therefore, depend upon single observations only, for their heights. It will be noticed, however, that where reciprocal and single observations are brought to bear upon the same station, there is generally a close coincidence in the results.

"The formulæ used are found in Malortie's Topography, vol. i., p. 131—135. They are as follows. (I have changed a few of the symbols for greater convenience.)

"1st. To reduce the angles as observed to the tops of the signals. At the point A, (Fig. 5,) an observer with the telescope at a observes the zenith distance* (= 90° ± the angle of depression or elevation, as the case may be,) of the top of the signal b′ at the point B. At B, with the telescope b, he observes the Z. D. of the top of the signal a′ at the point A. It is obvious that the angles, measured at the points a and b, are eccentric, and must be reduced to what they would be at a′ and b′, before they can be used in computing the difference of level between the points A and B.† To effect this, let the distance aa′, or the difference in height between the top of the signal and the telescope at the station A, be represented by ψ; the Z. D. measured at a by Δ, and the arc AB in ft, by K, then

Fig. 5.



$$(1.)\quad d = \frac{\psi \sin \Delta\, R''}{K} \qquad\qquad (2.)\quad \delta = \Delta + d.$$

And the same at the station B, where $\psi = bb'$; Δ the Z. D. measured at b, and $\delta' = \Delta + d$. d. being the correction in seconds to be applied to the observed angle.

"2d. To find the mean refraction in seconds. Let r = refraction; C the angle at the centre of the earth, or, which is the same thing, the arc A B contained between the two stations, expressed in terms of the arc, and let δ and δ' = corrected zenith distances; then

$$(3.)\quad r = \frac{C}{2} - \left(\frac{\delta + \delta' - 180°}{2}\right)$$

"This formula is founded upon the proposition, that if the sum of the two depressions be taken from the measure of the intercepted terrestrial arc, half the remainder is the refraction. If one of the objects is elevated, on account of the smallness of the arc, then if the depression be taken from the sum of the contained arc and elevation, half the remainder will be the refraction. The value in seconds of the arc A B may be found, with sufficient accuracy, by using the mean radius of the earth as given in the books.

"3d. To find the difference of level. Let H represent the difference of level between the tops of the signals at A and B; then

$$(4.)\quad H = K \tan\left(\frac{\delta' - \delta}{2}\right) \quad \text{or} \quad (5.)\quad H = \frac{K \sin \frac{1}{2}(\delta' - \delta)}{\cos \frac{1}{2}(\delta' - \delta + c)}$$

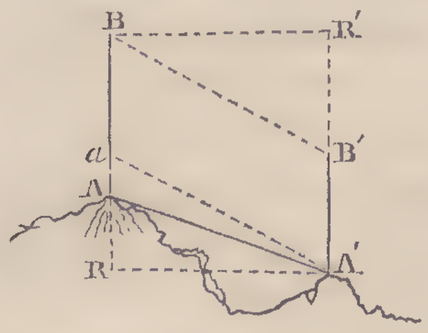
"The first of these two formulæ, although not exact, is yet sufficiently accurate for all practical purposes, and is the one which has been used in our calculations.

* We shall, hereafter, instead of zenith distance, frequently use the initials Z. D.

† The angles may, in like manner, be reduced to the height of the telescope of the instrument at the respective stations, or to the copper bolts which mark the stations, whichever may best suit the notions of the computer.

"Having the difference of level of the tops of the signals, that of the copper bolts marking the station points is found by applying a correction to H equal to the difference in height of the two signals. This correction is + (plus) when the shortest signal is elevated, and — (minus) when it is depressed, as may be seen in the annexed figure, (Fig. 6,) in which B′ R′ = difference of level between tops of signals, and A R = difference of level between bolts, but B′ R′ is greater than A R by the quantity A a, which is the difference in height of the signals A B and A′ B′ above the station marks, and which is to be added or deducted, therefore, as indicated above.

Fig. 6.



"Having thus given the formulæ used where reciprocal observations have been made, I here subjoin an example of their application to practice in this survey.

"At Nahant station, in Lynn, Sept. 14th, 1834, at $4\frac{1}{4}$, P. M., the measured zenith distance of the top of the signal on Blue Hill, in Milton, was 89° 45′ 35″.84.

Height of the telescope above the copper bolt marking Nahant station, = 4.83 ft.
Height of top of signal above copper bolt at Blue Hill station, . . . = 31.92

ψ = 27.09

"At Blue Hill station in Milton, Oct. 31st, 1834, at $2\frac{1}{2}$, P. M., the measured zenith distance of the top of the signal at Nahant station in Lynn was 90° 25′ 44″.58.

Height of telescope above the copper bolt marking Blue Hill station, = 13.63 ft.
Height of top of signal above copper bolt at Blue Hill station, . . = 34.93

ψ = 21.30

By (1.) At Blue Hill station, Δ = 90° 25′ 44″.58

ψ =	21 .30 ft.	
ψ = 21.30	log. =	1.3283796
Δ = 90° 25′ 44″.58	sin =	9.9999878
R'' =	log. =	5.3144251
K = 94402.74	ar. co. log. =	5.0250154
d =	46″.54 =	1.6678079

At Nahant station, Δ = 89° 45′ 35″.84

ψ =	27 .09	
ψ = 27.09	log. =	1.4328090
Δ = 89° 45′ 35″.84	=	9.9999962
R''	=	5.3144251
K	ar. co. log. =	5.0250154
d =	59″.19 =	1.7722457

(2.) $\Delta = 90° 25' 44''.58$
$d = \quad + 46 \ .54$

$\delta = 90 \ 26 \ 31 \ .12$
$\delta' = 89 \ 46 \ 35 \ .03$

$\delta - \delta' = \quad 39 \ 56 \ .09$

(4) $\frac{\delta - \delta'}{2} = \quad 19' \ 58''.05 \ \tan = 7.7640366$

$K = \quad 94402.74 \ \log. = 4.9749846$

$H = \quad 548.31 \ \log. = 2.7390212$

$\Delta = 89° 45' 35''.84$
$d = \quad + 59 \ .19$

$\delta' = 89 \ 46 \ 35 \ .03$
$\delta = 90 \ 26 \ 31 \ .12$

$\delta + \delta' - 180° = \quad 13 \ 06 \ .15$

(3.) $\frac{\delta + \delta' - 180°}{2} = \quad 6' \ 33''.08$

$\frac{C*}{2} = \quad 7 \ 46 \ .11$

$r = \frac{10 \ C}{128} = .078 \ C = \quad 1' \ 13''.03$

"The difference of level, therefore, between the tops of the signals at Blue Hill and Nahant stations being 548.31 ft., and the signal on Blue Hill being three feet higher above the bolt than that in Nahant, this quantity must be deducted from H, and the remainder, $= 548.31 - 3 = 545.31$ ft., will be the elevation of the bolt at Blue Hill above the bolt at Nahant.

"The bolt at Nahant has been ascertained, by levelling, to be 89.83 ft. above the mean level of the sea; therefore $89.83 + 545.31 = 635.14$ ft. will be the height of Blue Hill station above the sea by this observation.

"Where but one observation has been made, the following formula was applied; namely, $H = K \cot \left(\Delta + r - \frac{C}{2}\right)$; in which H = difference of level between the telescope at the place of observation, and the top of the signal observed. The difference of level of the bolts is obtained by applying a correction to H, equal to the difference between the

* To determine the value of C, we divide K by the value of a second deduced from the mean radius of the earth as determined by Mr. Ivory, its log = 2.0054651; thus:

$K = \log. \ 4.9749846$
$1'' = \log. \ 2.0054651$

$C = 932.22 = 2.9695195$

height above the bolts of the signal observed and the telescope at the place of observation. This correction is + (plus) when the signal observed is depressed, and — (minus) when it is elevated.

"The refraction, r, was obtained, in the easterly part of the state, by using .0784 C as a mean coefficient, derived from about twenty reciprocal observations. In the interior, the mean refraction was found to be less than on the sea-coast, and a mean coefficient of .06978 C was employed.

"The following example will illustrate the foregoing remarks:—

"At Blue Hill station, Oct. 30th, 1834, the telescope standing 13.63 ft. above the copper bolt, the measured zenith distance of Coddon's Hill station, in Marblehead, was 90° 22′ 11″.25. Height of signal at Coddon's above the bolt = 29.83 feet.

"By the formula given above,

$$\Delta = 90^\circ\ 22'\ 11''.25$$
$$r = .0784\ C = \quad +\ 1\ 41\ .62$$
$$90\ 23\ 52\ .87$$
$$\frac{C}{2} = \quad -\ 10\ 48\ .09$$
$$\Delta + r - \frac{C}{2} = 90\ 13\ 04\ .78 \text{ cot } = 7.5803348$$
$$K = \quad 131259.69 \quad \log. = 5.1181314$$
$$H = \quad 499.42 \quad \log. = 2.6984662$$

Correction for reduction to bolts = 29.83 — 13.63 = + 16.20

515.62 ft.

"Blue Hill is, therefore, elevated 515.62 ft. above Coddon's. The height of Coddon's Hill station, above the mean level of the sea, has been ascertained, by levelling, to be 117.75 feet; therefore, 117.75 + 515.62 = 633.37 feet is the result obtained, by this observation, for the height of Blue Hill station above the mean level of the sea. This is 1.77 feet less than that obtained by the reciprocal observation from Nahant, and giving the single observation one third weight, the mean will be 634.55 feet for the height of the station.

"In this manner the levels have been carried over the state, and the results have been highly satisfactory, proving sufficiently accurate to warrant the assertion that no point is in error more than six feet, and most of them are much nearer. A fair specimen of the work may be seen in the following table, in which the levels, taken from the sea at four stations distant from each other, are brought to bear upon one station. The four stations are Nahant, Telegraph Hill, Hyannis and Bullock's Neck stations; (the accompanying map of the triangles will show the relative positions of the stations named in the following table;) and the point where the levels from them meet is at Copecut station, in Fall River. In this table, where the sign + is prefixed to the numbers in the column of differences of level, it signifies that the station last named on the same line is elevated, and the contrary sign is used to denote a depression.

No.	Stations.	Difference of Level.	Refr. $C=1$.	Mean Height above Sea.	
	Nahant Station, above Sea, 89.83 feet.				
1.	Nahant and Blue Hill,	+ 545.31	.078	635.05	
2.	Nahant and Prospect Hill, Hingham,	+ 153.42	.077	243.25	
3.	Prospect Hill, Hingham and Monk's Hill,	+ 69.77	.087		
	Telegraph Hill, above Sea 205.30 feet.				
4.	Telegraph and Monk's Hills,	+ 107.56	.105	312.94	Mean height of Monk's Hill from (3) and (4) = 312.94.
5.	Prospect Hill, Hingham and Sprague's Hill,	— 49.72	.077		
6.	Blue and Sprague's Hills,	— 445.90	.071	192.24	
7.	Monk's and Sprague's Hills,	— 118.90	.050		Mean height of Sprague's from (5), (6), (7) = 192.24.
8.	Telegraph and Manomet Hills,	+ 186.64	.086	394.20	
9.	Monk's and Manomet Hills,	+ 83.53	.100		Mean height of Manomet from (8), (9) = 394.20.
10.	Manomet and Alden's Hills,	— 218.23	.081		
11.	Monk's and Alden's Hills,	— 136.77	.083	177.64	
12.	Sprague's and Alden's Hills,	— 11.46	.064		Mean height of Alden's from (10), (11), (12) = 177.64.
	Hyannis Station, above Sea 81.42 feet.				
13.	Hyannis and Falmouth stations,	+ 111.36	.091	192.78	
14.	Falmouth station and Great Hill,	— 65.80	.079	126.98	
15.	Great and Mendal's Hills,	+ 19.31	.094	146.29	
	Bullock's Neck Station, above Sea 15.80 feet.				
16.	Bullock's Neck and Rhode Island stations,	+ 270.37	.058	286.17	
17.	Rhode Island and Mount Hope stations,	— 70.42	.058	215.75	
18.	Mount Hope and Fall River stations,	+ 41.87	.094	257.62	
19.	Fall River and Copecut stations,	+ 96.47			Height above sea of Copecut
20.	Mendall's Hill and Copecut stations,	+ 210.18		354.69	from (19) = 354.09.
21.	Alden's Hill and Copecut stations,	+ 175.88			Do. from (20) = 356.47. Do. from (21) = 353.52.

"It will be seen that the height of Alden's Hill is determined from Nahant and Telegraph stations, the height of Mendal's Hill from Hyannis station, and the height of Fall River station from Bullock's Neck; and that the extremes of difference of these levels, in meeting on Copecut station, are only three feet. The levels from Nahant and Telegraph stations, meeting at Monk's Hill, differ but $\frac{18}{100}$ of a foot. This is the closest and fairest test which can be applied to trigonometrical levelling, and the result in this case is as near as could be reasonably expected.

"I will close this letter by a table, in which we start at Nahant station, and proceed, by *one chain* of levels, to Saddle Mount, in Berkshire, the highest point in the state.

No.	Stations.	Difference of Level.	Refr. $C=1$.	Height above Sea.	Mean Height above Sea.
1.	Nahant,			89.83	89.83
1.	Nahant and Blue Hill,	+ 545.31	.078	635.14	635.05
2.	Blue Hill and Fay's Mount,	+ 72.22	.079	707.36	707.36
3.	Fay's Mount and Bumsket Hill,	+ 700.07	.100	1407.43	1407.43
4.	Bumsket and Tuft's Hills,	— 233.95	.063	1173.48	1179.30
5.	Tuft's and Hawes' Hills,	+ 110.19		1283.67	1285.00
6.	Hawes' Hill and Packard's Mount,	— 2.59	.059	1281.08	1277.82
7.	Packard's and Bear Mounts,	+ 1.07	.049	1282.15	1281.33
8.	Bear Mount and Walnut Hill,	+ 604.54	.065	1886.69	1887.94
9.	Walnut Hill and Saddle Mount,	+ 1616.91	.091	3503.60	3505.50

"It will be seen by this table, that had the observed height of Saddle Mount depended on this chain of levels alone, it would have been about two feet less than the mean; and the greatest difference between any height as given by this table, and the same height as determined from a mean of all the observations brought to bear upon it, is at Tuft's Hill station, where the difference is nearly six feet."

SECTION V.—LATITUDES AND LONGITUDES OF TWENTY-SEVEN PLACES IN MASSACHUSETTS, ETC., AS DETERMINED, SOLELY, BY ASTRONOMICAL OBSERVATIONS, WITH PREFATORY REMARKS, BY R. T. PAINE.

The operations for ascertaining the latitudes and longitudes by astronomical observation were accomplished, without assistance, by Robert Treat Paine, Esq., under an appointment from Governor Lincoln. Mr. Paine's account of his labours and their results is contained in the following report, made to Governor Everett, of which a copy was furnished to me, and is now, for the first time, presented for publication.

To His Excellency Edward Everett, Esq.

Sir,—I have the honour herewith to present to the Executive of Massachusetts a table of the latitudes and longitudes of twenty-seven places, (twenty-three of which are in the said state, and the remainder in its immediate vicinity,) deduced by me from many thousand observations, made in pursuance of a resolve of the Legislature thereof, passed in 1830.

Being, sir, of opinion that a concise and popular explanation of the manner in which these observations were made would not be altogether unacceptable either to the Executive or the Legislature, I have taken the liberty to preface the report with the following remarks.

With the highest respect,
I am, your Excellency's obedient servant,
R. T. Paine.

Boston, March, 1838.

For the determination of the position of any place on the surface of the earth, it is necessary that two things should be known; namely, its latitude or distance north or south from the imaginary line or circle called the equator, and its longitude or distance east or west from another imaginary line or circle, which passes at right angles to the former, through some other place, which is assumed to be the first meridian.

Several methods have been proposed by which the latitude might be ascertained, but no one is as simple, or more accurate than that of measuring, with a suitable instrument, the altitude of the sun or other celestial body whose declination is known, when on or near the meridian. Indeed, so simple is this method, that when only an approximation to the truth is wanted, as at sea, a single altitude will give a result sufficiently exact; but

when precision is required, many altitudes of the sun, or, what is preferable, of stars, passing both to the north and south of the observer's zenith, must be taken, and the corrections of the altitudes for refraction and parallax, and of the stars' declinations, for aberration, nutation, and precession, must be carefully computed. The *accurate* solution of the problem, therefore, even by this method, is no longer easy, but requires much labour and time. Indeed, there is reason to doubt whether *perfect* accuracy can be obtained. In the Royal Observatory at Greenwich, which was established in 1675, are some of the largest astronomical instruments ever constructed, yet, within a few years, its latitude has been diminished one second; and the late director of that establishment has remarked, "that an error of half a second is even now not at all improbable, though it is rather unlikely that it should exceed that quantity." In the latitude of Greenwich, one second is equivalent to one hundred and one feet and five inches, and in Massachusetts to one hundred and one feet and three inches; the length of a degree of latitude, increasing gradually, but constantly, as we recede from the equator, in consequence of the ellipticity or flattening of the earth.

For the determination of the difference of the longitudes of two places there are many methods. But several of them, such as the eclipses of the moon, and of the satellites of Jupiter, and the distance of the moon from the sun or stars, are too uncertain to be resorted to when accuracy is requisite; and, indeed, no one of the various methods that have been proposed is altogether without its disadvantages. A single observation on the interval between the transit of the moon and a star may not give a result more accurate than a lunar distance, though the mean of several hundred of such observations, made in the course of several years, would probably be very correct. Eclipses of the sun, occultations of stars, and transits of the two inferior planets, are of very rare occurrence; moreover, the longitude of the place of observations will be affected by the errors in the tables of the sun, moon, planet, or star, unless corresponding observations were made on the same eclipse, occultation, or transit, at some other place, whose longitude is known, whereby the amount of such error may be discovered and taken into consideration. The explosion of gunpowder or of rockets, or the sudden extinction of a bright light on some conspicuous eminence, (a method which was used with much success in the recent determination of the longitudes of Greenwich and Paris,) requires the services of several practical astronomers; and the last method, which, in theory, is equally simple and perfect, that of transporting the time of one place to another by a chronometer, is liable to the objection, that although this is a beautiful, and even wonderful instrument, it is still not sufficiently perfect to be implicitly relied on. Such, however, is the comparative beauty and simplicity of this method, that it will hereafter be frequently adopted, especially for the determination of the difference of the longitudes of places not remote from each other; whilst, in order to avoid the difficulty above mentioned, several of these instruments must be employed, and the comparisons between the places must be repeated until, from the mean of all the observations, a result shall be obtained, nearly as accurate as can be hoped for.

It is, therefore, obvious that the determination of the exact longitude is not less difficult than of latitude. Indeed, it has been pronounced one of the most so of all the problems in practical astronomy. The astronomical observatories at Greenwich and Paris are not only two of the oldest, but perhaps the two most important in Europe: it

would seem, therefore, a matter of course that the difference of their longitudes should, long since, have been ascertained; yet, principally on account of the difficulty above mentioned, so late as the year 1775, a century after the establishment of the former, the supposed difference was erroneous by five and a half seconds of time; as it was then considered $9^m\ 16^s$; in 1780, Gen. Roy deduced from the trigonometrical survey of England, made under his direction, $9^m\ 18^s.8$; thirty-five years ago $9^m\ 20^s$ was used; and within a few years from observations on about one thousand transits of the moon and a star, and many on the explosion of rockets, $9^m\ 21^s.5$ was deduced, which is the quantity now used.

As the place from which longitude shall be reckoned is altogether arbitrary, it follows, as might have been expected, that different nations have fixed upon different places for the first meridian. Thus the English universally, and the Americans generally, reckon from the observatory at Greenwich, the French from that at Paris, the Germans from Berlin or Ferro, the Spanish from Cadiz, &c. It is much to be desired that some one place should be generally agreed on, and nothing but national prejudice has hitherto prevented the attainment of this object. It is highly probable that Greenwich will eventually be considered the first meridian, as already the two greatest commercial nations of the earth reckon from it, and as the observatory there has long been by common consent pronounced the most important and distinguished. Indeed, an eminent and gifted astronomer of France has remarked of the observations made at Greenwich, that if by a great revolution the observations made every where else were lost, and those only should be saved, there would be found in them materials sufficient to rear anew almost the entire edifice of modern astronomy.

I am well aware that in a few American maps the capitol at Washington has been adopted as the first meridian, for no other reason than that it is the building in which the national congress assembles. This step appears to me to be highly injudicious. The number of first meridians is not only thus increased, but the position of that building is not by any means well ascertained; indeed, from the observations made in its vicinity, on the annular eclipses of the sun of 1791, 1811 and 1831, I have deduced for its longitude a quantity *greater by more than six miles* than that usually assigned to it.

Moreover, if we consider Greenwich as the first meridian, the longitude of every part of the continent of America will be west; but if Washington or any other city in the United States be fixed on, part of our territory will be in east and part in west: this would be troublesome and inconvenient, and might be productive of serious error.

For these reasons the longitude of the following places has been reckoned from Greenwich, which I sincerely hope, will, in the construction of the map, be adopted as the first meridian.

For the determination of the latitudes of the places in the following table, the method above mentioned was generally adopted. Altitudes of the pole star (α Ursæ Minoris) were, however, measured when in any part of its circuit around the pole, and very many altitudes of southern stars were obtained, when at a short distance from the meridian to which they were reduced by the rules of spherical trigonometry. The altitudes of every star but the polar were reduced separately, and also of that when it was less than three hours from its upper or lower culmination.

It will be seen that the observations for the determination of the latitudes of all the

places but three, have been quite numerous; and of these three, it is believed a sufficient number was made for denoting their situations; they are not situate within the limits of the state, but so near that it is probable they will be comprehended by the map.

For the determination of the longitude of the State House in Boston, use was made of the observations there or in its vicinity, on every recent eclipse of the sun or occultation of a star, on which a corresponding observation was made, in some place in Europe. But, as usual, they were very few. It is believed that the only occultations seen there and in Europe, within several years past, were those of α Tauri in 1829 and 1830, and the only eclipse of the sun that of May 15th, 1836. From these three corresponding observations, I was able to deduce the errors of the lunar tables, and thus obtain for the longitude of the State House a quantity, less by only a tenth of a second, than that deduced by Doctor Bowditch in 1812, from six other observations, made between the years 1743 and 1807, which longitude he considered better ascertained than that of any other place in the United States.

The determination of the differences of the longitudes of the other twenty-six places, and of the State House, by observations, or the explosion of gunpowder or of rockets, on the summits of some of our highest hills, was reluctantly abandoned. As before observed, this method is not only very simple and accurate, but probably requires less time than any other; but it could not be adopted without the assistance of at least two persons well versed in practical astronomy, and it will be recollected that I have not had, at any time, the services of even one assistant.

The method, the last of those above enumerated, was therefore employed; namely, that of transporting the time of one place to another by chronometers; and, with a few exceptions, all the results stated in the following tables were in this manner obtained. In order to diminish as much as possible the probability of error, from any injury that might be sustained by the timekeepers whilst undergoing transportation, or from the local time at any place of observation not having been precisely ascertained, several of these instruments were generally used, (and even they were rarely depended on for a longer interval than twenty-four hours, and never for more than two days,) and the comparisons between the places in question were repeated again and again, until a result was obtained apparently deserving of confidence. Thus, on referring to the following table, it will be seen that the longitude of the First Congregational Church in Northampton was ascertained by seventy-four chronometers and twenty-four comparisons with the State House, or the Antiquarian Hall, in Worcester; that the longitude of the new Court House in Barnstable was ascertained by fifty-nine chronometers and seventeen comparisons, &c., &c. And it will be, moreover, noticed, that the difference between the greatest and least longitudes of any place thus determined was seldom equal to two seconds of time.

The local time at any place was ascertained, not by a transit instrument, but by an artificial horizon of quicksilver, and a reflecting instrument that had been constructed for me by the celebrated Troughton. It was usual to measure at least six altitudes of a bright star in the east, and directly as many of another star in the west, or the reverse. As it was but seldom that the errors of the chronometers deduced from the two sets of altitudes differed two-thirds of a second, and as the mean of these errors was used, there is every reason to suppose that the local time was thus well ascertained.

For the determination of the time or latitude but little use was comparatively made of the sun, as its great heat, especially in the summer, not unfrequently causes an unequal expansion of the instrument employed for the mensuration of its altitude, and consequently the result therefrom deduced would be rendered somewhat erroneous, and less to be relied on. But the use of the stars, of course, rendered it necessary that the observations should be made at all hours of the night; and as they were made in the open air, without any protection or covering whatever, and at nearly every season, much fatigue and suffering were not unfrequently experienced.

On referring to the following table it will be seen, that the position of at least one place in every county has been ascertained; also, the positions of nearly all the largest towns, of our three colleges, at Amherst, Cambridge, and Williamstown, and of that at Providence, which, although situate in another state, is but little more than a mile from our undisputed boundary. It is uncertain whether observations have hitherto been made for the accurate determination of the situations of more than six of the places contained in the table, and if the results of my observations are correct, the position of no one of the six was ascertained with any degree of precision. The *latitude* of Cambridge, (and of Boston, which was deduced from it by triangulation,) has hitherto been laid down too great by a mile and a quarter; that of Providence, by a mile and a third; that of Salem, by upwards of two miles; that of Nantucket, too small by merely a mile and a half; and that of the Lighthouse in Truro, usually known as the Highland or Cape Cod Light, has generally been laid down in the charts and in treatises on navigation yet more erroneous, namely, too great by three English miles. This last is the more surprising, as this lighthouse is, by far, the most important on the coast of New England, since from it many of the most valuable ships, sailing from Boston, Salem, or other places in Massachusetts Bay, take their "departure," and as it is generally the first object seen from them on their return.

In consequence of the altitude and azimuth instrument, which was imported expressly for the purpose of making the observations, not proving satisfactory, the acceptance thereof was declined. It therefore became necessary (much time having been already lost) to make use of the reflecting instrument before mentioned, fortunately in my possession.

This instrument, though comparatively small, and not such as would have been preferred, has, however, given results so closely accordant with each other as to inspire me with great confidence in their accuracy. Indeed it would surprise me, should it hereafter appear that the positions of either of the places in the following table, are therein stated, erroneous, in any important degree.

Latitudes of twenty-seven Places in Massachusetts, &c.

	Latitudes, North.
Boston, State House,	42° 21′ 22″.7
Amherst, College Chapel,	22 12 .6
Barnstable, New Court House,	41 42 7 .3
Bristol, R. I., Episcopalian Church,	40 2 .9
Cambridge, First Congregational Church,	42 22 21 .3
Dedham, " " "	14 52 .3
Gloucester, First Independent Church,	36 44 .2
Greenfield, Second Congregational Church,	35 16 .3

	Latitudes, North.
Hartford, Conn., State House,	41° 45′ 59″.1
Holmes Hole, Windmill west of the village,	27 15 .3
Lowell, St. Ann's Church,	42 38 47 .6
Monomoy Point, Light House,	41 33 30 .8
Nantucket, South Tower,	16 56 .0
New Bedford, Mariners' Church,	38 6 .3
Newburyport, Harris Street Church,	42 48 32 .1
Northampton, First Congregational Church,	19 8 .0
Pittsfield, " " "	26 55 .0
Plymouth, Court House,	41 57 28 .5
Portsmouth, N. H., Unitarian (stone) Church,	43 4 34 .6
Providence, R. I., University Hall,	41 49 31 .9
Salem, East India Marine Hall,	42 31 18 .9
Sandwich, First Congregational Church,	41 45 31 .0
Springfield, Court House,	42 6 1 .2
Taunton, Trinitarian Congregational Church,	41 54 8 .3
Truro, Cape Cod Lighthouse,	42 2 22 .2
Williamstown, Congregational Church near College,	42 50 .6
Worcester, Antiquarian Hall,	16 12 .6

Longitudes of twenty-seven places in Massachusetts, &c.

	From the State House.		From Greenwich.	
	In Degrees.	In Time.	In Degrees.	In Time.
Boston, State House,			71° 4′ 9″.0	4h 44m 16s.60
Amherst, College Chapel,	+ 1° 27′ 26″.9	+ 5m 49s.79	72 31 35 .9	50 6 .39
Barnstable, Court House,	— 0 45 33 .0	— 3 2 .20	70 18 36 .0	41 14 .40
Bristol, R. I., Episcopalian Church,	+ 0 13 10 .5	+ 0 52 .69	71 17 19 .5	45 9 .29
Cambridge, First Congregational Church,	+ 0 3 29 .1	+ 0 13 .94	71 7 38 .1	44 30 .54
Dedham, " " "	+ 0 6 40 .2	+ 0 26 .68	71 10 49 .2	44 43 .28
Gloucester, First Independent Church,	— 0 23 50 .0	— 1 35 .33	70 40 19 .1	42 41 .27
Greenfield, Second Congregational Church,	+ 1 32 23 .0	+ 6 9 .53	72 36 32 .0	50 26 .13
Hartford, Conn., State House,	+ 1 36 36 .3	+ 6 26 .42	72 40 45 .3	50 43 .02
Holmes Hole, Windmill,	— 0 27 31 .2	— 1 50 .08	70 36 37 .8	42 26 .52
Lowell, St. Ann's Church,	+ 0 14 48 .3	+ 0 59 .22	71 18 57 .3	45 15 .82
Monomoy Point, Light House,	— 1 4 3 .6	— 4 16 .24	70 0 5 .4	40 0 .36
Nantucket, South Tower,	— 0 57 56 .9	— 3 51 .79	70 6 12 .2	40 24 .81
New Bedford, Mariners' Church,	— 0 8 19 .7	— 0 33 .31	70 55 49 .4	43 43 .29
Newburyport, Harris Street Church,	— 0 11 21 .9	— 0 45 .46	70 52 47 .1	43 31 .14
Northampton, First Congregational Church,	+ 1 34 12 .0	+ 6 16 .80	72 38 21 .0	50 33 .10
Pittsfield, " " "	+ 2 11 56 .1	+ 8 47 .74	73 16 5 .1	53 4 .34
Plymouth, Court House,	— 0 23 41 .4	— 1 34 .76	70 40 27 .6	42 41 .84
Portsmouth, N. H., Stone Church,	— 0 18 19 .2	— 1 13 .28	70 45 49 .8	43 3 .32
Providence, R. I., University Hall,	+ 0 20 39 .0	+ 1 22 .60	71 24 48 .0	45 39 .20
Salem, East India Marine Hall,	— 0 10 12 .3	— 0 40 .82	70 53 56 .7	43 35 .78
Sandwich, First Congregational Church,	— 0 33 42 .0	— 2 14 .80	70 30 27 .0	42 1 .80
Springfield, Court House,	+ 1 31 38 .3	+ 6 6 .55	72 35 47 .3	50 23 .15
Taunton, Trinitarian Congregational Church,	+ 0 1 55 .5	+ 0 7 .70	71 6 4 .5	44 24 .30
Truro, Cape Cod Lighthouse,	— 1 0 0 .3	— 4 0 .02	70 4 8 .7	40 16 .58
Williamstown Congregational Church,	+ 2 9 10 .5	+ 8 36 .70	73 13 19 .5	52 53 .30
Worcester, Antiquarian Hall,	+ 0 44 1 .2	+ 2 56 .08	71 48 10 .2	47 12 .68

West Longitudes are designated thus +
East " " " " —

Boston, (State House.) For the Latitude.

1828 and 1829,	194	altitudes of ⊙	gave	42° 21′ 21″.7
1833, April,	12	"	" "	24 .7
"	11	"	" "	23 .9
"	14	"	" "	19 .9
"	10	"	" "	24 .6
September,	12	"	" "	23 .2
1834, March,	8	"	" "	26 .5
May,	20	"	α Ursæ Minoris gave	24 .8
"	34	"	" " "	24 .5
1835, "	17	"	α ♍ "	23 .4
"	6	"	" "	26 .4
June,	15	"	" "	24 .9
May,	18	"	α Ursæ Minoris "	26 .4
June,	10	"	" " "	25 .3
1837, October,	8	"	β Ceti "	21 .9
"	14	"	α Ursæ Minoris "	20 .5
"	2	"	" " "	21 .7
"	7	"	β Ceti "	24 .5
November,	10	"	" "	22 .4
"	16	"	α Ursæ Minoris "	20 .8
December,	2	"	β Ceti "	20 .2
"	12	"	α Ursæ Minoris "	20 .9
"	10	"	⊙ "	20 .3
"	12	"	β Ceti "	21. 1
"	2	"	α Ursæ Minoris "	24 .6
"	15	"	β Orionis "	24 .8
"	20	"	α Ursæ Minoris "	25 .5
"	12	"	β Ceti "	19 .1
"	16	"	⊙ "	18 .9
"	16	"	α Ursæ Minoris "	19 .5
"	13	"	" " "	24 .6
"	12	"	β Orionis "	20 .3
"	5	"	β Ceti "	23 .8
"	4	"	α Ursæ Minoris "	24 .0
"	12	"	" " "	23 .2
"	13	"	β Orionis "	26 .2
"	10	"	δ " "	24 .8
"	12	"	α Ursæ Minoris "	21 .1
	431	altitudes of ⊙ and Southern Stars,		22 .24
	205	" " Northern "		23 .36
	Mean of 636 observations,			42° 21′ 22″.7

Boston, (State House.) For the Longitude.

Several years since, the longitude of the State House was deduced by Dr. Bowditch from observations made in its vicinity, on the following phenomena; namely,—

The Transit of ☿,	Nov. 5th, 1743, gave	$4^h\ 44^m\ 19^s.2$
Eclipse " ⊙,	Aug. 5th, 1766, "	17 .5
Transit " ♀,	June 3d, 1769, "	18 .0
Eclipse " ⊙,	June 24th, 1778, "	14 .9
" " "	April 3d, 1791, "	18 .0
" " "	June 16th, 1806, "	11 .8
Mean Longitude from these six observations,		$4^h\ 44^m\ 16^s.6$

And it was the opinion of Dr. Bowditch, that "this longitude is more accurately ascertained than that of any other place in the United States."

From the observations on the occultations of α Tauri, a star of the first magnitude, on August 21st, 1829, and January 5th, 1830, made in many of the observatories of Europe, and in this city by myself, I deduced the longitude of the State House to be $4^h\ 44^m\ 14^s.6$. And from the observations made at Greenwich and at Dorchester, by a friend, and at Providence by myself, on the great eclipse of the sun, of May 15th, 1836, I deduced $4^h\ 44^m\ 19^s.6$.

The mean of these three observations is $16^s.3$, or only three-tenths of a second less than the longitude determined by Dr. Bowditch; and the mean of the nine observations is only one-tenth of a second less, a quantity too small to be noticed.

I therefore state the longitude of the State House (west from the Royal Observatory at Greenwich) to be $4^h\ 44^m\ 16^s.6$, or, in degrees, 71° 4′ 9″.0.

Amherst, (College Chapel.) For the Latitude.

1832, October,	26 altitudes of the ⊙ gave		42° 22′	11″.4
1834, August,	14 "	α Aquilæ		13 .6
"	14 "	α Ursæ Minoris		13 .8
"	4 "	" "		13 .2
"	12 "	β Ceti		12 .5
"	9 "	α Ursæ Minoris		12 .0
1836, "	10 "	" "		11 .4
"	10 "	α Aquilæ		11 .9
"	10 "	α Ursæ Minoris		14 .8
	62 "	⊙ and Southern Stars		12 .19
	47 "	" Northern "		13 .11
	Mean of 109 observations,		42 22	12 .6

Amherst, (College Chapel.) For the Longitude.

1832, October,	By 2 chronometers east of Mansion House, Northampton,		$0^m\ 27^s.76$
1833, October,	2 " " " " "		28 .42
"	2 " " " " "		28 .27
1834, August,	2 " " " " "		27 .11
"	2 " " " " "		26 .88
1835, August,	4 " " " " "		27 .69
September,	4 " " " " "		28 .59
1836, August,	3 " " " " "		28 .36
	Mean of 21 chronometers, east of Mansion House, Northampton,	—	27 .96
	Longitude of Northampton,	+ 6	17 .72
	Longitude of Amherst College Chapel,	+ 5	49 .76

II.

1832, October,	By 2 chronometers west of State House,	$+\ 5^m\ 50^s.03$

III.

1832, October,	By 2 chronometers west of Antiquarian Hall, Worcester,	$+\ 2^m\ 53^s.82$
	Longitude of Ant. Hall, Worcester,	+ 2 56 .08
	Longitude of Amherst College Chapel,	+ 5 49 .90
	By 2 chronometers compared directly with State House,	$+\ 5^m\ 50^s.03$
2	" " " " Worcester,	49 .90
21	" " " " Northampton,	49 .76
	Mean of 25 chronometers,	+ 5 49 .79
	Or from Greenwich,	4 50 6 .39

Barnstable, (New Court House.) *For the Latitude.*

1832, April,	39	altitudes of ⊙	gave	41° 42′	7″.8
"	21	"	" "		5 .9
Sept.	18	"	" "		7 .9
1835, June,	6	"	2 α ♎ gave		2 .0
"	8	"	β ♎ "		5 .3
"	8	"	α Ursæ Minoris gave		1 .8
"	6	"	β ♏ "		4 .3
"	11	"	2 α ♎ "		6 .4
"	4	"	β ♎ "		7 .3
"	12	"	α ♏ "		8 .9
"	15	"	α Ursæ Minoris "		5 .8
"	15	"	" " "		8 .6
July,	20	"	" " "		7 .0
1837, June,	10	"	" " "		10 .4
"	6	"	α ♐ "		7 .1
"	6	"	" "		6 .9
"	10	"	α Ursæ Minoris "		7 .6
"	12	"	α ² ♎ "		8 .8
"	10	"	α Ursæ Minoris "		8 .2
"	10	"	" " "		10 .3
"	10	"	" " "		7 .8
"	10	"	α ♏ "		8 .1
		159 altitudes of ⊙ and Southern Stars,			7 .09
		108 " " Northern "			7 .53
		Mean of 267 observations,		41° 42′	7″.3

Barnstable, (New Court House.) *For the Longitude.*

1832, September,	By 2 chronometers east of State House,			3m 3s.44
"	2	" " " "		0 .36
1835, June,	4	" " " "		2 .70
July,	4	" " " "		2 .40
1837, June,	4	" " " "		2 .98
"	4	" " " "		1 .99
July,	4	" " " "		2 .95
"	4	" " " "		1 .35
"	3	" " " "		1 .88
	Mean of 31 chronometers,			3m 2s.28

II.

1832, September,	By 2 chronometers east of Plymouth Court House,			1m 28s.03
"	2	" " " " "		26 .81
1835, June,	4	" " " " "		28 .13
"	4	" " " " "		27 .22
1837, June,	4	" " " " "		28 .44
"	4	" " " " "		26 .73
July,	4	" " " " "		26 .72
	Mean of 24 chronometers,			— 1 27 .44
	Longitude of Plymouth,			— 1 34 .76
	Longitude of Barnstable,			— 3 2 .20

III.

1832, April,	By 4 chronometers east of the Mariners' Church, in New Bedford,		— 2m 28s.44
	Longitude of New Bedford,		— 33 .31
	Longitude of Barnstable,		— 3 1 .75
	By 31 chronometers compared with the State House,		3m 2s.28
	24 " " " Plymouth,		2 .20
	4 " " " New Bedford,		1 .75
	Mean of 59 chronometers,		— 3 2 .20
	Or, from Greenwich,		4 41 14 .40

Bristol, R. I., (Episcopal Church.) ***For the Latitude.***

1832, March,	44 altitudes of ⊙ gave		41° 40′ 1″. 0
1837, August,	2 " β Ceti gave		3 . 6
"	8 " α Ursæ Minoris gave		4 . 9
Sept.	12 " " " "		3 . 0
"	12 " α Aquilæ "		5 . 9
	58 altitudes of ⊙ and Southern Stars,		2 .10
	20 " " Northern "		3 .76
	Mean of 78 observations,		41° 40′ 2″. 9

Bristol, R, I.,(Episcopal Church.) ***For the Longitude.***

1832, April,	By 4 chronometers east of Providence University Hall,	29s.65
1837, August,	4 " " " " "	30 .77
	Mean of 8 chronometers,	— 30 .21
	Longitude of Providence,	+ 1 22 .60
	Longitude of Bristol,	+ 0 52 .39

II.

1832, April,	By 4 chronometers west of New Bedford,	1m 26s.59
1837, Sept.	4 " " " "	26 .01
	Mean of 8 chronometers,	+ 1 26 .30
	Longitude of New Bedford,	— 33 .31
	Longitude of Bristol,	+ 52 .99
	By 8 chronometers compared with Providence University Hall	+ 0m 52s.39
	8 " " " New Bedford Mariners' Church,	0 52 .99
	Mean of 16 chronometers,	+ 0 52 .69
	Or, from Greenwich,	4 45 9 .29

Cambridge, the First Congregational Church, (Mr. Newell's.) ***For the Latitude.***

1835, May,	11 altitudes of α Ursæ Minoris gave		42° 22′ 19″.7
"	21 " α ♍ "		19 .8
"	16 " α Ursæ Minoris "		22 .1
"	17 " " " "		19 .9
"	10 " " " "		18 .4
"	22 " α ♍ "		21 .7
"	20 " α Ursæ Minoris "		21 .4
"	12 " α ♍ "		21 .3
"	10 " α Ursæ Minoris "		18 .9

1837, Oct.	10 altitudes of α Aquilæ gave		42° 22′ 24″.0
"	10 " α Ursæ Minoris gave		22 .9
"	12 " β Ceti "		23 .7
"	10 " α Ursæ Minoris "		24 .1
"	10 " " " "		21 .1
"	10 " $\odot$ "		20 .5
	87 altitudes of $\odot$ and Southern Stars,		21 .60
	114 " " Northern "		20 .98
	Mean of 201 observations,		42 22 21 .3

Cambridge, (First Congregational Church.) *For the Longitude.*

1835, May,	By 3 chronometers west of the State House,	14ˢ.66
"	3 " " " " " "	14 .17
"	3 " " " " " "	14 .20
"	3 " " " " " "	14 .06
1837, Oct.	4 " " " " " "	13 .19
"	4 " " " " " "	13 .67
	Mean of 20 chronometers,	+ 13 .94
	Or, from Greenwich,	4 44 30 .54

Dedham, First Congregational Church, (Dr. Samson's.) *For the Latitude.*

1835, May,	17 altitudes of α ♍ gave		42° 14′ 52″.4
"	16 " α Ursæ Minoris gave		53 .7
"	26 " α ♍ "		50 .9
"	24 " α Ursæ Minoris "		54 .4
"	20 " α ♍ "		51 .5
"	13 " α Ursæ Minoris "		54 .9
"	18 " α ♍ "		52 .4
"	12 " α Ursæ Minoris "		54 .5
"	12 " β ♎ "		48 .2
"	10 " β ♏ "		53 .8
"	10 " α Ursæ Minoris "		47 .5
1837, May,	10 " α ♍ "		51 .6
"	10 " α Ursæ Minoris "		50 .8
	113 altitudes of Southern Stars,		51 .50
	85 " Northern "		53 .12
	Mean of 198 observations,		42° 14′ 52″.3

Dedham, (First Congregational Church.) *For the Longitude.*

1834, Sept.	By 3 chronometers west of State House,	26ˢ.68
1835, May,	3 " " " " " "	26 .62
"	3 " " " " " "	26 .08
"	3 " " " " " "	26 .22
June,	3 " " " " " "	27 .73
1837, May,	4 " " " " " "	27 .00
"	4 " " " " " "	26 .39
	Mean of 23 chronometers,	+ 26 .68
	Or, from Greenwich,	4 44 43 .28

Gloucester, (*First Independent or Universalist Church.*) *For the Latitude.*

1834, Sept.	12	altitudes of	α Ursæ Minoris	gave	42° 36′ 48″.4
"	13	"	⊙	"	49 .1
"	4	"	α Ursæ Minoris	"	46 .9
1835, July,	20	"	" "	"	43 .0
"	10	"	α Aquilæ	"	42 .0
"	8	"	η Ophiuchi	"	44 .2
"	20	"	α Ursæ Minoris	"	45 .1
"	12	"	" "	"	41 .3
"	20	"	" "	"	41 .9
"	12	"	α Aquilæ	"	42 .0
Oct.	4	"	β Ceti	"	43 .0
"	12	"	α Ursæ Minoris	"	45 .4
"	10	"	" "	"	46 .6
"	12	"	β Orionis	"	42 .5
		59	altitudes of ⊙ and Southern Stars,		44 .03
		110	" " Northern	"	44 .32
		Mean of 169 observations,			42° 36′ 44″.2

Gloucester, (*First Independent Church, formerly Dr. Murray's.*) *For the Longitude.*

1834, Sept.	By 4 chronometers east of the State House,		— 1^m 35^s.68
1835, July,	4	"	36 .68
Aug.	4	"	35 .46
Oct.	4	"	34 .54
"	4	"	34 .80
1836, July,	4	"	35 .93
Aug.	4	"	34 .90
	Mean of 28 chronometers,		— 1^m 35^s.43

II.

1834, Sept.	By 2 chronometers east of Salem Lafayette Hotel,		54^s.32
1835, Aug.	4	"	54 .27
Oct.	4	"	54 .67
"	4	"	54 .11
1836, July,	4	"	55 .06
"	4	"	54 .89
	Mean of 22 chronometers,		— 54 .57
	Or, adding the longitude of Salem Lafayette Hotel,		— 40 .59
			— 1^m 35 .16

III.

1834, Sept.	By 2 chronometers east of Newburyport Harris Street Church,		49^s.91
1835, Oct.	4	"	49 .55
1836, July,	4	"	50 .34
	Mean of 10 chronometers,		— 49 .94
	Or, adding the longitude of Newburyport,		— 45 .46
			— 1^m 35^s.40
	By 28 chronometers compared with the State House,		— 1^m 35^s.43
	22 " " " Salem,		35 .16
	10 " " " Newburyport,		35 .40
	Mean by 60 chronometers from State House,		— 1^m 35^s.33
	" " " " Greenwich,		4^h 42 41 .27

Greenfield, (Second Congregational Church.) For the Latitude.

1834, August,	8 altitudes of β Ceti gave		42° 35′ 20″.8
"	13 "	α Aquilæ gave	18 .3
"	11 "	α Ursæ Minoris gave	17 .7
"	21 "	" " "	16 .2
"	10 "	β Ceti "	17 .1
"	10 "	α Ursæ Minoris "	13 .4
1836, August,	8 "	β Ceti "	16 .1
"	14 "	α Ursæ Minoris "	14 .7
"	8 "	α Aquilæ	13 .6
"	10 "	α Ursæ Minoris "	13 .8
	47 altitudes of Southern Stars,		17 .30
	66 " Northern "		15 .34
	Mean of 113 observations,		42° 35′ 16″.3

Greenfield, (Second Congregational Church.) For the Longitude.

1833, July,	By 2 chronometers west of State House,	+ 6^m 8^s.48
"	2 " " " "	9 .69
	Mean of 4 chronometers,	+ 6 9 .09

II.

1834, August,	By 2 chronometers east of Northampton Mansion House,	8^s.22
"	2 " " " " "	7 .78
1836, "	3 " " " " "	7 .57
"	3 " " " " "	8 .39
	Mean of 10 chronometers,	— 7 .99
	Longitude of Northampton,	+ 6 17 .72
	Longitude of Greenfield,	+ 6 9 .73
	By 4 chronometers compared with State House,	+ 6 9^s.09
	10 " " Northampton,	9 .73
	Mean of 14 chronometers,	+ 6 9 .53
	Or, from Greenwich,	4 50 26 .13

Hartford, (State House.) For the Latitude.

1836, August,	6 altitudes of α Aquilæ gave		41° 46′ 1″.3
"	3 "	β Ceti gave	45 52 .2
"	14 "	α Ursæ Minoris gave	59 .9
	9 altitudes of Southern Stars,		58 .3
	14 " Northern,		59 .9
	Mean of 23 observations,		41° 45′ 59 .1

Hartford, (State House.) For the Longitude.

1836, August,	By 3 chronometers west of Springfield Court House,	20^s.19
"	3 " " " " "	19 .55
	Mean of 6 chronometers,	+ 19 .87
	Longitude of Springfield,	+ 6^m 6 .55
	Longitude of Hartford,	+ 6 26^s.42
	By 6 chronometers compared with Springfield,	+ 6^m 26^s.42
	Or from Greenwich,	4 50 43 .02

Holmes Hole, (Windmill West of Village.) For the Latitude.

1834, October,	12	altitudes of	β Ceti gave	41° 27′ 18″.2
"	10	"	α Ursæ Minoris gave	12 .3
"	14	"	⊙ "	11 .0
"	10	"	β Ceti "	12 .3
"	10	"	α Ursæ Minoris "	10 .3
1835, Sept.	12	"	α Aquilæ "	19 .0
"	10	"	α Ursæ Minoris "	16 .6
"	10	"	" " "	19 .2
"	12	"	β Orionis "	17 .3
Oct.	10	"	β Ceti "	20 .4
"	11	"	α Ursæ Minoris "	20 .3
"	17	"	⊙ "	12 .9
1836, Oct.	12	"	β Orionis "	12 .7
"	10	"	α Ursæ Minoris "	15 .1
"	14	"	α Canis Majoris "	13 .6
		113 altitudes of ⊙ and Southern Stars,		15 .02
		61 " " Northern "		15 .76
		Mean of 174 observations,		41° 27′ 15″.3

Holmes Hole, (Windmill.) For the Longitude.

1834, Oct.	By 2 chronometers east of New Bedford Mariners' Church,		— 1ᵐ 16ˢ.65
1835, Sept.	4 " " " " " "		15 .87
Oct.	4 " " " " " "		17 .22
"	4 " " " " " "		15 .94
1836, April,	4 " " " " " "		16 .77
"	4 " " " " " "		17 .29
Oct.	4 " " " " " "		17 .30
	Mean of 26 chronometers,	— 1	16 .72
	Longitude of New Bedford,	—	33 .31
	Longitude of Holmes Hole, (Windmill,)	— 1	50 .03

II.

1834, Oct.	By 2 chronometers west of South Tower, Nantucket,		— 2ᵐ 1ˢ.85
1835, Sept.	4 " " " " " "		1 .70
1836, Oct.	4 " " " " " "		1 .33
	Mean of 10 chronometers,	+ 2	1 .58
	Longitude of South Tower,	— 3	51 .75
	Longitude of Holmes Hole	— 1	50 .17
	By 26 chronometers compared with New Bedford,		— 1ᵐ 50ˢ.03
	10 " " " Nantucket,		50 .17
	Mean of 36 chronometers,	— 1	50 .08
	Or, from Greenwich,	4 42	26 .52

Lowell, (St. Ann's Church.) For the Latitude.

The place of observation is 2″.13 south of the church, which correction is to be applied throughout, to reduce the observations to that building.

1833, April,	12	altitudes of ⊙ gave		42° 38′ 44″.2
"	12	" " "		48 .1
"	12	" " "		50 .7
"	12	" " "		41 .5
1834, May,	12	" α ♍ gave		50 .1
"	13	" α Ursæ Minoris gave		44 .3
"	6	" " " "		47 .7
"	17	" " " "		45 .0
June,	14	" α ♍ "		50 .9
"	15	" α Ursæ Minoris "		45 .2
"	15	" α ♏ "		49 .7
"	10	" α Ursæ Minoris "		43 .0
"	11	" β Ursæ Minoris "		45 .7
"	15	" α ♏ "		48 .8
"	21	" α Ursæ Minoris "		41 .4
"	15	" α ♏ "		47 .3
"	14	" α Ursæ Minoris "		41 .1
"	15	" " " "		45 .7
"	10	" β ♎ "		44 .9
"	3	" α ♏ "		50 .4
Sept.	10	" β Ceti "		41 .4
"	10	" α Ursæ Minoris "		43 .1
1836, June,	12	" α ♏ "		47 .7
"	14	" α Ursæ Minoris "		40 .0
	154	altitudes of ⊙ and Southern Stars,		47 .41
	146	" " Northern "		43 .55
	300	"		45 .48
		Add reduction to the church,		2 .13
		Mean of 300 observations, latitude of church,		42° 38′ 47″.6

Lowell, (St. Ann's Church.) For the Longitude.

The place of observation is 0ˢ.38 west of the church, which correction is to be applied throughout, to reduce the following observations to that building.

1833, April,	By 2 chronometers west of State House,		+	59ˢ.27
"	2	" " " "		60 .57
1834, May,	2	" " " "		59 .08
June,	2	" " " "		60 .11
"	2	" " " "		59 .44
Sept.	2	" " " "		60 .01
"	2	" " " "		60 .72
1836, June,	3	" " " "		59 .52
"	3	" " " "		59 .38
1837, July,	4	" " " "		58 .53
"	4	" " " "		59 .64
	Mean of 28 chronometers,			59ˢ.52

II.

1833, April,	By 2 chronometers west of Newburyport, Harris Street Church, -	1m 45s.19
1834, June,	2 " " " " " " " -	45 .32
"	2 " " " " " " " - -	45 .70
	Mean of 6 chronometers, - - - - -	+ 1m 45s.41
	Longitude of Newburyport, - - - - - -	— 45 .46
	Longitude of Lowell, - - - - - -	+ 59 .95
	By 28 chronometers compared with the State House, - - -	+ 59 .52
	6 " " " Newburyport, - - -	59 .95
	Mean of 34 chronometers, - - - - - -	+ 59 .60
	Reduction to the church, - - - - - -	— 0 .38
	Longitude of the church by 34 chronometers, - - -	+ 0m 59s.22
	Or, from Greenwich, - - - - - -	4 45 15 .82

Monomoy Point, or Cape Malabar, (Lighthouse.) For the Latitude.

1831, February,	28 altitudes of ☉ gave - - - - - - -		41° 33′ 30″.1
"	24 " " " " - - - - - - -		29 .8
"	10 " α Canis Majoris gave - - - - -		31 .6
1835, June,	20 " α Ursæ Minoris " - - - - -		27 .5
"	7 " β ♏ " - - - - -		33 .5
"	6 " α ♏ " - - - - -		28 .2
"	10 " α Ursæ Minoris " - - - - -		34 .2
"	10 " " " " - - - - -		28 .7
"	4 " α ♏ " - - - - -		34 .7
"	10 " β ♎ " - - - - -		33 .3
"	6 " β ♏ " - - - - -		35 .5
"	10 " α ♏ " - - - - -		30 .4
"	11 " α Ursæ Minoris " - - - - -		32 .2
	105 altitudes of ☉ and Southern Stars, - - - -		31″.11
	51 " " Northern " - - - -		30 .06
	Mean of 156 observations, - - - - -		41° 33′ 30″.8

Monomoy Point, (Lighthouse.) For the Longitude.

1831, February,	By 2 chronometers east of State House, - - - - -	4m 16s.51

II.

1835, June,	By 4 chronometers east of Barnstable Court House, - - -	1m 15s.17
"	4 " " " " " " - - -	13 .51
	Mean of 8 chronometers, - - - - -	— 1 14 .34
	Longitude of Barnstable, - - - - - -	— 3 2 .20
	Longitude of Monomoy, - - - - - -	— 4 16 .54

III.

The whole of the annular eclipse of the sun which happened February 12th, 1831, was observed by me at this Lighthouse; but, in consequence of clouds, only the beginning was visible in Dorchester. By combining the observations made there with those made at the Lighthouse on the beginning and end, and the formation and rupture of the ring, I deduced for the longitude of the Lighthouse — 4m 15s.5.

	By 2 chronometers compared with the State House,			— 4m 16s.51
	8 " " " Barnstable,			16 .54
	By the annular eclipse of the Sun of Feb. 12th, 1831,			15 .50
	Mean of all,			— 4 16 .24
	Or, from Greenwich,			4 40 0 .36

Nantucket, (South Tower.) *For the Latitude.*

1833, March,	16 altitudes of ⊙ gave			41° 16′ 58″.7
August,	3 " ϖ Aquilæ gave			53 .6
Sept.	12 " ⊙ "			53 .2
"	10 " " "			52 .1
"	8 " α Aquilæ "			54 .7
"	9 " ⊙ "			55 .7
"	10 " α Aquilæ "			54 .4
"	10 " ⊙ "			58 .2
"	10 " " "			57 .6
"	11 " α Aquilæ "			55 .7
1834, Oct.	5 " ⊙ "			54 .7
"	4 " " "			50 .5
"	11 " α Ursæ Minoris gave			55 .8
1835, Sept.	10 " β Ceti "			54 .2
"	16 " α Ursæ Minoris "			56 .5
"	12 " α Aquilæ "			57 .3
"	11 " β Ceti "			56 .7
"	13 " α Ursæ Minoris "			56 .5
"	12 " " " "			56 .7
"	11 " β Orionis "			52 .4
"	10 " β Ceti "			57 .9
"	12 " α Ursæ Minoris "			57 .9
1836, Oct.	10 " " " "			56 .3
"	12 " β Ceti "			56 .6
"	12 " α Ursæ Minoris "			56 .3
	174 altitudes of ⊙ and Southern Stars,			55″.61
	86 " " Northern "			56 .58
	Mean of 260 observations,			41° 16′ 56 .0

Nantucket, (South Tower.) *For the Longitude.*

1833, March,	By 2 chronometers east of New Bedford Mariners' Church,			— 3m 18s.59
"	2 " " " " " "			18 .01
Aug.	2 " " " " " "			19 .55
Sept.	2 " " " " " "			18 .20
1834, Oct.	2 " " " " " "			18 .50
"	2 " " " " " "			18 .84
1835, Sept.	4 " " " " " "			18 .82
"	4 " " " " " "			17 .57
1836, Oct.	4 " " " " " "			18 .48
"	4 " " " " " "			18 .63
	Mean of 28 chronometers,			— 3 18 .48
	Longitude of New Bedford Mariners' Church,			33 .31
	Longitude of Nantucket,			— 3 51 .79
	Or, from Greenwich,			4 40 24 .81

New Bedford, (Mariners' Church, a little North of Mansion House.) *For the Latitude.*

1832, March,	47 altitudes of ⊙ gave		41° 38′	4″.8
April,	27 " " "			5 .5
"	2 " " "			11 .2
"	30 " " "			5 .9
1833, March,	12 " " "			9 .3
"	12 " " "			7 .3
"	3 " " "			7 .8
"	12 " " "			7 .2
"	18 " " "			10 .4
"	12 " " "			5 .9
Sept.	7 " " "			2 .4
"	1 " α Aquilæ gave			9 .5
"	1 " " "			4 .3
1834, Oct.	11 " ⊙ "			2 .8
"	10 " α Ursæ Minoris gave			3 .3
"	10 " " " "			8 .5
"	6 " β Ceti "			2 .3
"	12 " α Ursæ Minoris "			8 .3
1835, Sept.	4 " β Ceti "			5 .4
"	10 " α Ursæ Minoris "			7 .3
"	10 " " " "			7 .2
"	12 " β Orionis "			6 .7
1836, Oct.	11 " α Ursæ Minoris "			5 .6
"	12 " ⊙ "			4 .6
"	10 " α Ursæ Minoris "			8 .0
1837, Sept.	10 " β Ceti "			7 .4
"	10 " α Ursæ Minoris "			5 .1
	239 altitudes of ⊙ and Southern Stars,			6″.05
	83 " " Northern "			6 .69
	Mean of 322 observations,		41° 38′	6″.3

New Bedford, (Mariners' Church.) *For the Longitude.*

1832, April,	By 2 chronometers east of the State House,	— 33ˢ.75
1833, March,	2 " " " " "	33 .47
April,	2 " " " " "	33 .53
Aug.	2 " " " " "	33 .10
Sept.	2 " " " " "	33 .55
1834, Oct.	2 " " " " "	33 .22
"	2 " " " " "	32 .56
1835, Sept.	4 " " " " "	33 .33
"	4 " " " " "	31 .92
Oct.	4 " " " " "	33 .37
"	4 " " " " "	33 .71
1836, April,	4 " " " " "	33 .10
Oct.	4 " " " " "	33 .59
"	4 " " " " "	33 .11
1837, Sept.	4 " " " " "	33 .63
"	4 " " " " "	33 .46
	Mean of 50 chronometers,	— 33ˢ.27

II.

1832, April,	By 4 chronometers west of Barnstable Court House,		+ 2m 28s.44
	Longitude of Barnstable by comparison with State House,		— 3 2 .25
	Longitude of New Bedford,		— 0 33 .81
	By 50 chronometers compared with the State House,		— 33s.27
	4 " " " Barnstable,		33 .81
	Mean of 54 chronometers,		— 0m 33s.31
	Or, from Greenwich,		4 43 43 .29
	Newburyport, (Presbyterian Church in Harris Street.)	*For the Latitude.*	
1833, April,	11 altitudes of ⊙ gave		42° 48′ 34″.0
"	12 " " "		32 .3
1834, March,	8 " " "		33 .0
"	12 " " "		30 .0
"	10 " α Hydræ gave		35 .0
April,	21 " α Ursæ Minoris gave		35 .9
"	19 " " " "		27 .4
"	12 " ⊙ "		35 .7
"	19 " α Ursæ Minoris "		33 .8
June,	10 " " " "		32 .0
"	10 " α ♏ "		27 .9
"	6 " α Ursæ Minoris "		29 .6
1835, Oct.	12 " " " "		32 .6
"	14 " β Orionis "		30 .5
1836, July,	14 " α Ursæ Minoris "		31 .5
"	12 " α Aquilæ "		30 .3
	101 altitudes of ⊙ and Southern Stars,		32″.06
	101 " " Northern "		32 .16
	Mean of 202 observations,		42° 48′ 32″.1
	Newburyport, (Church in Harris, near State Street.)	*For the Longitude.*	
1833, April,	By 2 chronometers east of State House,		45s.92
"	2 " " " "		46 .27
1834, March,	2 " " " "		46 .03
April,	2 " " " "		44 .60
Sept.	2 " " " "		45 .21
1835, Oct.	4 " " " "		44 .99
"	4 " " " "		45 .25
1836, July,	3 " " " "		44 .64
"	3 " " " "		45 .51
1837, Aug.	4 " " " "		45 .63
	Mean of 28 chronometers,		— 45 .49

II.

1833, April,	By 2 chronometers east of Salem Lafayette Hotel,	5s.72
1834, Sept.	2 " " " " "	4 .41
1835, Oct.	4 " " " " "	5 .12
"	4 " " " " "	4 .56
1836, July,	3 " " " " "	4 .64
"	3 " " " " "	4 .63
	Mean of 18 chronometers,	— 4 .82
	Longitude of Salem,	— 40 .59
		— 45 .41

Longitude by 28 chronometers compared with State House,	— 45ˢ.49
" 18 " " Salem,	45 .41
Mean of 46 chronometers,	— 45 .46
Or, from Greenwich,	4 43 31 .14

Northampton, (First Congregational Church.) For the Latitude.

The Mansion House, the place where the following observations were made, being 3″.39 south of the church, that quantity must be constantly added.

1832, Oct.	15	altitudes of ⊙ gave	42° 19′	2″.7
1833, June,	6	" α ♏ gave		2 .9
Oct.	7	" β Ceti gave		5 .3
"	8	" ⊙ "		0 .0
"	6	" α Canis Majoris gave		0 .2
"	10	" ⊙ "		3 .5
Dec.	14	" " "		2 .3
"	6	" " "		11 .4
"	20	" " "		6 .3
"	11	" α Ursæ Minoris "		5 .8
"	33	" " " "		2 .5
"	19	" ⊙ "		5 .4
"	4	" β Ursæ Minoris "		2 .0
"	21	" α Ursæ Minoris "		5 .6
"	20	" ⊙ "		9 .6
"	15	" α Ursæ Minoris "		5 .2
"	21	" ⊙ "		2 .6
1834, July,	12	" α Aquilæ "		4 .7
"	12	" α Ursæ Minoris "		3 .6
Aug.	5	" β Ursæ Minoris "		8 .0
"	12	" α Ursæ Minoris "		6 .5
"	8	" β Ceti "		1 .3
"	10	" α Ursæ Minoris "		3 .7
"	12	" " " "		2 .9
1836, Sept.	10	" " " "		7 .2
"	10	" α Aquilæ "		8 .6
	182	altitudes of ⊙ and Southern Stars,		4 .72
	145	" " Northern, "		4 .52
	327	Latitude of Mansion House,	42° 19′	4″.62
		Add reduction to church,		3 .39
		Mean of 327 observations, latitude of church,	42° 19′	8″.0

Northampton, (First Congregational Church.) For the Longitude.

The Mansion House being 0ˢ.92 west of the church, that quantity must be constantly added, to reduce the observations to the meridian of the church.

1832, Oct.	By 2	chronometers west of the State House,	6ᵐ 17ˢ.80
1833, June,	2	" " " " "	19 .05
July,	2	" " " " "	17 .87
Dec.	3	" " " " "	17 .68
1834, July,	2	" " " " "	18 .82

1834, July,	By 3 chronometers west of the State House,		$6^m\ 18^s.97$
August,	4 " " " " "		18 .20
1835, "	4 " " " " "		16 .78
Sept.	4 " " " " "		17 .96
1836, August,	4 " " " " "		17 .04
Sept.	4 " " " " "		17 .01
1837, "	4 " " " " "		18 .85
"	4 " " " " "		16 .94
	Mean of 42 chronometers,		+ 6 17 .81

II.

1832, Oct.	By 2 chronometers west of Antiquarian Hall, Worcester,		$3^m\ 21^s.58$
1833, June,	2 " " " " "		22 .82
July,	2 " " " " "		21 .51
Oct.	2 " " " " "		21 .72
1834, July,	2 " " " " "		22 .61
1835, Aug.	4 " " " " "		20 .66
Sept.	4 " " " " "		21 .91
1836, Aug.	3 " " " " "		21 .29
Sept.	3 " " " " "		21 .14
1837, Oct.	4 " " " " "		20 .98
"	4 " " " " "		22 .72
	Mean of 32 chronometers,		+ 3 21 .54
	Add Longitude of Worcester,		+ 2 56 .08
			$+\ 6^m\ 17^s.62$
	By 42 chronometers compared with the State House,		+ 6 17 .81
	32 " " " Worcester,		17 .62
	Mean of 74 chronometers, (Mansion House,)		+ 6 17 .72
	Add reduction to the church,		— 0 0 .92
	Longitude of the church by 74 chronometers,		+ 6 16 .80
	Or, from Greenwich,		4 50 33 .40

On the 22d of August, 1836, the immersion of the star τ^1 behind the dark limb of the moon was observed, by a friend, in Dorchester, and by myself at the Mansion House. The immersion took place at Dorchester, mean time, at $10^h\ 23^m\ 20^s.90$, and at the Mansion House at $10^h\ 14^m\ 57^s.46$; from which I have deduced the difference of longitude between the two places of observation to be $6^m\ 17^s.20$. To which add $0^s.69$ for the longitude of Dorchester, and subtract the reduction $0^s.92 \pm 0^s.23$, and we have, for the difference of the longitude of the State House and church, $6^m\ 16^s.97$, which differs only one-sixth of a second from the results given by the seventy-four chronometers.

Pittsfield, (First Congregational Church.) *For the Latitude.*

1832, October,	16 altitudes of ☉ gave		42° 26′ 51″.4
1833, June,	6 " α ♏ gave		57 .9
"	10 " " "		58 .5
Oct.	8 " α Canis Majoris gave		48 .7
"	9 " ☉ "		53 .4
Nov.	20 " " "		56 .3
"	12 " α Ursæ Minoris "		53 .8

1833, Nov.	2 altitudes of β Ceti gave		42° 26′ 56″.3
"	20 " ⊙ gave		57 .1
"	20 " " "		53 .8
"	20 " α Ursæ Minoris gave		55 .4
"	14 " β Orionis "		59 .9
1834, July,	1 " α Ursæ Minoris "		53 .8
"	9 " " " "		50 .4
Aug.	10 " " " "		54 .8
"	8 " α Aquilæ "		54 .5
"	10 " α Ursæ Minoris "		55 .3
"	11 " α Aquilæ "		55 .1
1836, Aug.	4 " α Ursæ Minoris "		58 .2
	144 altitudes of ⊙ and Southern Stars,		55 .32
	66 " " Northern "		54 .50
	Mean of 210 observations,		42° 26′ 55″.0

Pittsfield, (First Congregational Church.) For the Longitude.

1833, July,	By 2 chronometers west of Northampton, Mansion House,	2^m 29^s.73
Oct.	2 " " " " "	29 .68
1834, July,	4 " " " " "	31 .02
Aug.	4 " " " " "	31 .11
1835, "	4 " " " " "	29 .22
Sept.	4 " " " " "	29 .24
1836, Aug.	3 " " " " "	30 .74
"	3 " " " " "	29 .93
	Mean of 26 chronometers,	+ 2 30 .12
	Add longitude of Northampton, Mansion House,	+ 6 17 .72
		+ 8^m 47^s.84

II.

1832, Oct.	By 2 chronometers west of Springfield Court House,	2^m 41^s.52
1833, July,	2 " " " " "	41 .03
1835, Sept.	4 " " " " "	40 .40
	Mean of 8 chronometers,	+ 2 40 .84
	Add longitude of Springfield Court House,	+ 6 6.55
		+ 8 47 .39

III.

1833, July,	By 2 chronometers west of Greenfield Second Congregational Church,	2^m 39^s.12
1836, Aug.	3 " " " " " "	38 .31
	Mean of 5 chronometers,	+ 2 38 .63
	Add longitude of Greenfield,	+ 6 9 .53
		+ 8 48 .16
	By 26 chronometers compared with Northampton,	+ 8^m 47^s.84
	8 " " " Springfield,	8 47 .39
	5 " " " Greenfield,	8 48 .16
	Mean of 39 chronometers,	+ 8^m 47^s.74
	Or, from Greenwich,	4 53 4 .34

Plymouth, (Court House.) For the Latitude.

1830, Dec.	5	altitudes of ⊙	gave	41° 57′ 26″.6
1831, Sept.	1	"	"	25 .0
Oct.	1	"	"	33 .5
"	1	"	"	26 .8
"	6	"	"	27 .2
1832, Sept.	11	"	"	28 .9
"	2	"	"	31 .7
"	13	"	"	26 .7
"	19	"	"	31 .1
1835, April,	24	"	α Ursæ Minoris gave	32 .1
"	16	"	α ♍ "	22 .4
"	20	"	α Ursæ Minoris "	32 .6
"	19	"	α ♍ "	24 .5
"	3	"	" "	31 .4
1837, May,	14	"	" "	27 .4
"	14	"	α Ursæ Minoris "	27 .6
	111	altitudes of ⊙ and Southern Stars,		27 .05
	58	" " Northern "		31 .18
	Mean of 169 observations,			41° 57′ 28″.5

Plymouth, (Court House.) For the Longitude.

1832, Sept.	By 2	chronometers east of State House,		1m 35s.41
"	2	" " " "		33 .60
1835, April.	3	" " " "		33 .46
"	3	" " " "		33 .40
June,	4	" " " "		34 .57
July,	4	" " " "		35 .18
1837, May,	4	" " " "		35 .54
June,	3	" " " "		35 .36
July,	4	" " " "		35 .52
"	4	" " " "		34 .63
	Mean of 33 chronometers,			— 1 34 .76
	By 33 chronometers compared with the State House,			— 1m 34s.76
	Or, from Greenwich,			4 42 41 .84

Portsmouth, N. H., (Stone Church, Mr. Peabody's.) For the Latitude.

1836, July,	10	altitudes of α Ursæ Minoris	gave	43° 4′ 38″.8
"	9	" α Aquilæ	"	30 .2
1837, Aug.	10	" α Ursæ Minoris	"	34 .2
"	8	" α Aquilæ	"	34 .9
	17	altitudes of Southern Stars,		32 .41
	20	" Northern,		36 .50
	Mean of 37 observations,			43° 4′ 34″.6

Portsmouth, N. H., (Unitarian, or Stone Church.) For the Longitude.

1836, July,	By 3	chronometers east of the State House,		1m 13s.70
"	3	" " " " "		12 .39
1837, Aug.	4	" " " " "		13 .42
	Mean of 10 chronometers,			— 1 13 .19

II.

1836, July,	By 3 chronometers east of Newburyport Church,	28s.19
"	3 " " " "	27 .76
1837, Aug.	4 " " " "	27 .79
	Mean of 10 chronometers,	— 27 .90
	Longitude of Newburyport,	— 45 .46
		— 1 13 .36
	By 10 chronometers compared with the State House,	— 1m 13s.19
	10 " " " Newburyport,	13 .36
	Mean of 20 chronometers,	— 1 13 .28
	Or, from Greenwich,	4 43 3 .32
	Providence, (*University Hall, or Old College.*) *For the Latitude.*	
1832, Jan.	42 altitudes of ⊙ gave	41° 49′ 27″.4
March,	37 " " "	32 .7
"	32 " " "	32 .4
"	46 " " "	36 .1
Nov.	26 " " "	27 .7
1836, May,	11 " α Ursæ Minoris gave	37 .3
"	12 " α ♍ "	32 .2
"	10 " α Ursæ Minoris "	34 .5
"	17 " " " "	35 .2
"	13 " α ♍ "	28 .6
"	14 " " "	27 .2
"	14 " α Ursæ Minoris "	29 .4
Oct.	10 " " " "	30 .4
1837, Aug.	12 " " " "	32 .0
"	12 " α Aquilæ	32 .6
	234 altitudes of ⊙ and Southern Stars,	31 .24
	74 " " Northern "	33 .15
	Mean of 308 observations,	41° 49′ 31″.9
	Providence, (*University Hall.*) *For the Longitude.*	
1832, March,	By 2 chronometers west of the State House,	+ 1m 22s.44
Nov.	2 " " " " "	22 .50
1836, May,	4 " " " " "	22 .56
"	4 " " " " "	22 .09
"	4 " " " " "	22 .57
Oct.	4 " " " " "	22 .08
"	4 " " " " "	22 .32
1837, Aug.	4 " " " " "	23 .14
"	4 " " " " "	23 .31
	Mean of 32 chronometers,	+ 1 22s.57

II.

1832, April,	By 4 chronometers west of New Bedford Mariners' Church,	+ 1m 56s.24
1837, Sept.	4 " " " " " "	56 .77
	Mean of 8 chronometers,	+ 1 56 .50
	Add Longitude of New Bedford,	— 33 .31
		+ 1 23 .19

The great eclipse of the sun, of May 15th, 1836, was observed by me in Providence. By combining my observations with those made at Greenwich, I deduced the longitude of Providence, $4^h\ 45^m\ 42^s.05$, and the Longitude of the State House, by the observations made at Dorchester, $4^h\ 44^m\ 19^s.76$. Hence, by this eclipse, longitude of Providence, $+\ 1^m\ 22^s.29$.

By 32 chronometers compared with the State House,	+ 1	22 .57
8 " " " New Bedford,		23 .19
By the beginning and end of eclipse of the sun, May 15th, 1836,		22 .29
Mean of 40 chronometers and the eclipse,	+ 1	22 .60
Or, from Greenwich,	4 45	39 .20

Salem, (East India Marine Hall.) For the Latitude.

The following observations were made in the yard of the Lafayette Hotel, at a point 0″.69 north of the Hall: that quantity must, therefore, be constantly subtracted, to reduce the observations to the Hall.

1833, April,	5	altitudes of ⊙ gave	42° 31′ 18″.2
"	8	" " "	22 .6
1834, April,	23	" α Ursæ Minoris gave	21 .8
"	13	" " " "	20 .6
"	4	" α ♍ "	17 .4
"	14	" α Ursæ Minoris "	15 .8
"	14	" α ♍ "	21 .1
"	10	" α Ursæ Minoris "	20 .4
"	11	" α ♍ "	19 .1
"	12	" " "	21 .8
1835, Oct.	10	" α Ursæ Minoris "	17 .8
1836, July,	10	" " " "	17 .4
"	10	" α Aquilæ "	20 .2
Oct.	10	" α Ursæ Minoris "	16 .9
64 altitudes of ⊙ and Southern Stars,			20″.48
90 " " Northern, "			19 .06
Mean of 154 observations, latitude of Hotel, place of observation,			19 .64
Reduction to front of Hall,			— 0 .69
Mean of 154 observations, latitude of Hall, north front,			42° 31′ 18″.9

Salem, (East India Marine Hall.) For the Longitude.

The following observations were made in the yard of the Lafayette Hotel, at a point $0^s.23$ west of the Hall.

1833, April,	By 2	chronometers east of State House,	40ˢ.85
"	2	" " " "	40 .56
1834, "	2	" " " "	40 .53
"	2	" " " "	39 .80
"	2	" " " "	40 .14
Sept.	2	" " " "	40 .80
1835, Aug.	4	" " " "	41 .18
Oct.	4	" " " "	39 .87
"	4	" " " "	40 .69
1836, July,	3	" " " "	40 .87
"	3	" " " "	40 .01

1836, Oct.	By 4 chronometers east of State House,		40ˢ.83
"	4 " " " "		40 .84
1837, Aug.	4 " " " "		40 .81
	Mean of 42 chronometers, longitude of Hotel,		— 40 .59
	Reduction to the Hall,		— 0 .23
	Longitude of Hall,		— 40 .82
	Mean of 42 chronometers, longitude of the Hall,		— 40ˢ.82
	Or, from Greenwich,		4 43 35 .78

Sandwich, (*First Congregational Church.*) *For the Latitude.*

1832, April,	32 altitudes of ⊙ gave		41° 45′ 29″.4
"	20 " " "		35 .8
1835, July,	12 " α Ursæ Minoris gave		27 .8
1837, June,	10 " α ♍ "		33 .4
"	12 " α Ursæ Minoris "		31 .1
"	8 " α² ♎ "		34 .3
"	12 " α Ursæ Minoris "		29 .1
"	13 " α ♏ "		29 .3
"	10 " α Ursæ Minoris "		29 .0
"	10 " " " "		31 .3
	83 altitudes of ⊙ and Southern Stars,		31″.88
	56 " " Northern "		29 .62
	Mean of 139 observations,		41° 45′ 31″.0

Sandwich, (*First Congregational Church.*) *For the Longitude.*

1832, Sept.	By 2 chronometers east of Plymouth Court House,	—	40ˢ.16
"	2 " " " " "		38 .74
1835, July,	4 " " " " "		39 .74
1837, June,	4 " " " " "		40 .08
"	4 " " " " "		40 .18
	Mean of 16 chronometers,	—	39 .86
	Longitude of Plymouth,	— 1	34 .76
		— 2	14 .62

II.

1832, April,	By 2 chronometers west of Barnstable Court House,	+	46ˢ.15
Sept.	2 " " " " "		47 .87
"	2 " " " " "		48 .07
1835, July,	4 " " " " "		47 .48
1837, June,	4 " " " " "		48 .36
"	4 " " " " "		46 .55
	Mean of 18 chronometers,	+	47 .42
	Longitude of Barnstable,	— 3	2 .20
		— 2ᵐ	14ˢ.78

III.

1832, April,	By 2 chronometers east of New Bedford,	— 1ᵐ	42ˢ.41
"	2 " " " "		42 .17
	Mean of 4 chronometers,	— 1	42 .29
	Longitude of New Bedford,	—	33 .31
		— 2	15 .60

	By 16 chronometers compared with Plymouth,		— 2m 14s.62
	18 " " " Barnstable,		14 .78
	4 " " " New Bedford,		15 .60
	Mean of 38 chronometers,		— 2 14 .80
	Or, from Greenwich,		4 42 1 .80

Springfield, (Court House.) ***For the Latitude.***

1832, Oct.	16 altitudes of ⊙ gave		42° 5′ 56″.5
1834, July,	20 " α Ursæ Minoris gave		58 .6
"	11 " α Aquilæ "		63 .7
"	4 " α Ursæ Minoris "		64 .1
"	20 " " " "		61 .2
"	12 " α Aquilæ "		66 .2
"	16 " α Ursæ Minoris "		57 .5
"	15 " α Aquilæ "		62 .4
"	4 " α Ursæ Minoris "		57 .0
"	14 " α Aquilæ "		64 .6
"	14 " α Ursæ Minoris "		61 .9
1836, Aug.	11 " β Ceti "		61 .0
"	11 " α Ursæ Minoris "		63 .2
	79 altitudes of ⊙ and Southern Stars,		62″.16
	89 " " Northern "		60 .25
	Mean of 168 observations,		42° 6′ 1″.2

Springfield, (Court House.) ***For the Longitude.***

1832, Oct.	By 2 chronometers east of Northampton Mansion House,		11s.21
1833, June,	2 " " " " "		11 .30
1834, July,	3 " " " " "		11 .32
1835, Sept.	4 " " " " "		11 .60
"	4 " " " " "		10. 60
1836, Aug.	4 " " " " "		10 .63
1837, Sept.	4 " " " " "		11 .10
"	4 " " " " "		10 .96
	Mean of 27 chronometers,		— 11 .06
	Longitude of Northampton,		+ 6m 17s.72
			+ 6 6 .66

II.

1833, June,	By 2 chronometers west of State House,		6m 7s.75
July,	2 " " " "		6 .57
1836, Aug.	4 " " " "		6 .41
"	4 " " " "		5 .57
	Mean of 12 chronometers,		6 6 .38

III.

1833, June,	By 2 chronometers west of Antiquarian Hall, Worcester,		3m 11s.52
July,	2 " " " " "		10 .21
1836, Aug.	4 " " " " "		10 .66
"	4 " " " " "		9 .70
	Mean of 12 chronometers,		+ 3 10 .41
	Longitude of Worcester, Antiquarian Hall,		2 56 .08
			+ 6 6 .49

Mean of 27 chronometers compared with Northampton,		+ 6m	6s.66
12 " " " State House,			6 .38
12 " " " Worcester,			6 .49
Mean of 51 chronometers,		+ 6	6 .55
Or, from Greenwich,		4 50	23 .15

Taunton, (Trinitarian Congregational Church.) *For the Latitude.*

1833, March,	12 altitudes of ⊙ gave	41° 54′	9″.0
"	12 " " "		9 .8
Aug.	12 " " "		8 .0
1834, Oct.	12 " α Ursæ Minoris gave		5 .7
"	10 " β Ceti "		8 .0
"	11 " α Ursæ Minoris "		5 .3
"	9 " ⊙ "		8 .6
1835, Sept.	18 " α Ursæ Minoris "		10 .2
"	6 " β Ceti "		9 .8
"	10 " α Ursæ Minoris "		9 .4
"	8 " β Ceti "		9 .3
"	10 " α Ursæ Minoris "		9 .4
"	7 " β Ceti "		8 .5
"	10 " α Ursæ Minoris "		6 .7
"	14 " β Orionis "		7 .9
"	4 " α Ursæ Minoris "		5 .5
1837, Sept.	8 " β Ceti "		9 .9
"	8 " α Ursæ Minoris "		8 .0
	98 altitudes of ⊙ and Southern Stars,		8″.79
	83 " " Northern "		7 .85
	Mean of 181 observations,	41° 54′	8″.3

Taunton, (Trinitarian Congregational Church, nearly opposite the County House.) *For the Longitude.*

1833, March,	By 2 chronometers west of State House,	7s.73
Aug.	2 " " " "	7 .73
1834, Oct.	2 " " " "	8 .15
1835, Sept.	4 " " " "	7 .44
"	4 " " " "	8 .34
1837, Sept.	4 " " " "	7.69
	Mean of 18 chronometers,	7.84

II.

1833, March,	By 2 chronometers west of New Bedford Mariners' Church,	41s.20
Aug.	2 " " " " "	40 .83
1834, Oct.	2 " " " " "	41 .37
1835, Sept.	4 " " " " "	40 .77
"	4 " " " " "	40 .26
1837, "	4 " " " " "	41 .15
	Mean of 18 chronometers,	+ 40 .87
	Longitude of New Bedford,	— 33 .31
		+ 7s.56

By 18 chronometers compared with the State House,	+	7ˢ.84
18 " " " New Bedford,	+	7 .56
Mean of 36 chronometers,	+	7ˢ.70
Or, from Greenwich,	4 44	24 .30

Truro, (Cape Cod or Highland Lighthouse.) For the Latitude.

1832, April,	8 altitudes of ⊙ gave	42° 2′ 26″	.4
1835, Aug.	1 " α Ursæ Minoris gave		21 .5
"	3 " " " "		21 .6
"	5 " α Aquilæ "		20 .2
"	25 " α Ursæ Minoris "		20 .0
"	18 " α Aquilæ "		19 .6
"	21 " α Ursæ Minoris "		20 .8
"	20 " α Aquilæ "		20 .8
"	10 " α Ursæ Minoris "		25 .4
"	12 " β Ceti "		24 .4
"	22 " α Ursæ Minoris "		24 .8
"	10 " α Ursæ Minoris "		25 .7
"	13 " α Aquilæ "		23 .0
"	18 " β Ceti "		20 .2
"	16 " α Ursæ Minoris "		23 .4
"	12 " β Ceti "		22 .0
"	14 " α Ursæ Minoris "		22 .1
106 altitudes of ⊙ and Southern Stars,			21 .70
122 " " Northern "			22 .65
Mean of 228 observations,		42° 2′ 22″	.2

Truro, (Cape Cod Lighthouse.) For the Longitude.

1835, Aug.	By 4 chronometers east of the State House,	— 3ᵐ 59ˢ.19
"	4 " " " " "	60 .89
"	3 " " " " "	58 .95
"	3 " " " " "	59 .75
Mean of 14 chronometers,		— 3 59 .74

II.

1832, April,	By 2 chronometers east of Barnstable Court House,	— 57ˢ.33
1835, July,	4 " " " " "	58 .46
"	4 " " " " "	58 .37
Mean of 10 chronometers,		— 58 .20
Longitude of Barnstable,		— 3 2 .20
		— 3 60 .40
By 14 chronometers compared with the State House,		— 3 59 .74
10 " " " Barnstable,		60 .40
Mean of 24 chronometers,		— 4 0 .02
Or, from Greenwich,		4 40 16 .58

Williamstown, (Congregational Church, West of College.) For the Latitude.

1833, June,	20 altitudes of	α ♏ gave		42° 42′ 52″.2
Nov.	2 "	⊙ "		58 .8
1834, July,	10 "	α Ursæ Minoris gave		48. 6
"	10 "	" " "		46 .5
"	6 "	α Aquilæ "		49 .1
"	13 "	" "		52 .5
"	10 "	α Ursæ Minoris "		49 .5
"	7 "	α Aquilæ "		49 .9
"	5 "	α Ursæ Minoris "		50 .5
1836, Aug.	15 "	α Aquilæ "		52 .0
"	12 "	α Ursæ Minoris "		50 .4
	63 altitudes of ⊙ and Southern Stars,			51 .8
	47 " " "	Northern "		49 .0
	Mean of 110 observations,			42° 42′ 50″.6

Williamstown, (Congregational Church.) For the Longitude.

1833, July,	By 2 chronometers east of Pittsfield Church,		— 11ˢ.62
Nov.	2 " " " "		10 .49
"	2 " " " "		11 .48
1834, July,	4 " " " "		11 .14
"	4 " " " "		10 .59
1836, Aug.	3 " " " "		11 .32
	Mean of 17 chronometers,		— 11 .04
	Longitude of Pittsfield by comparison with Northampton and Springfield,		+ 8 47 .73
			+ 8 36 .69

II.

1836, Aug.	By 3 chronometers west of Northampton Mansion House,		2ᵐ 19ˢ.42
"	3 " " " " "		18 .61
	Mean of 6 chronometers,		+ 2 19. 02
	Longitude of Northampton,		+ 6 17 .72
			+ 8 36 .74

III.

1833, July,	By 2 chronometers west of Greenfield Church,		2ᵐ 27ˢ.50
1836, "	3 " " " "		26 .99
	Mean of 5 chronometers,		+ 2 27 .19
	Longitude of Greenfield,		+ 6 9 .53
			+ 8 36 .72
	By 17 chronometers compared with Pittsfield,		+ 8ᵐ 36ˢ.69
	6 " " " Northampton,		36 .74
	5 " " " Greenfield,		36 .72
	Mean of 28 chronometers,		+ 8 36 .70
	Or, from Greenwich,		4 52 33 .30

Worcester, (Antiquarian Hall.) For the Latitude.

1832, Oct.	22 altitudes of ⊙ gave		42° 16′ 9″.8
"	18 " " " "		13 .4
"	21 " " " "		15 .1
1833, Dec.	20 " α Ursæ Minoris gave		11 .1
"	11 " ⊙ "		7 .5
"	21 " α Ursæ Minoris "		10 .2
"	11 " β " " "		8 .3
"	20 " ⊙ "		15 .1
"	13 " α Ursæ Minoris "		15 .0
"	14 " " " " "		6 .8
"	20 " ⊙ "		12 .9
"	8 " " "		14 .9
1834, July,	15 " α ♏ "		16 .5
Aug.	11 " α Ursæ Minoris "		14 .1
1835, Nov.	12 " ⊙ "		15 .4
"	10 " α Ursæ Minoris "		11 .5
"	10 " β Ceti "		16 .7
"	10 " α Ursæ Minoris "		13 .9
"	14 " ⊙ "		11 .5
"	10 " " "		11 .1
"	10 " α Ursæ Minoris "		14 .6
1836, Sept.	10 " " " " "		14 .1
"	10 " β Ceti "		12 .6
"	10 " α Ursæ Minoris "		13 .9
1837, Oct.	10 " " " "		11 .2
"	10 " β Ceti "		11 .1
	201 altitudes of ⊙ and Southern Stars,		13″.15
	150 " " Northern "		11 .77
	Mean of 351 observations,		42° 16′ 12″.6

Worcester, (Antiquarian Hall.) For the Longitude.

1832, Oct.	By 2 chronometers west of the State House,		2^{m} 56^{s}.21
1833, June,	2 " " " " " "		56 .23
July,	2 " " " " " "		56 .36
Dec.	3 " " " " " "		55 .96
1834, July,	2 " " " " " "		56 .21
Aug.	2 " " " " " "		55 .15
"	2 " " " " " "		55 .74
1835, "	4 " " " " " "		56 .12
Sept.	4 " " " " " "		56 .05
Nov.	4 " " " " " "		55 .81
"	4 " " " " " "		57 .17
1836, Aug.	3 " " " " " "		55 .75
Sept.	3 " " " " " "		55 .87
1837, Oct.	4 " " " " " "		56 .13
"	4 " " " " " "		55 .96
	Mean of 45 chronometers,		+ 2 56 .08
	Mean of 45 chronometers compared with the State House,		+ 2^{m} 56^{s}.08
	Or, from Greenwich,		4 47 12 .68

SECTION VI.—COMPARISON OF THE RESULTS OF MR. BORDEN'S TRIANGULATION, WITH THOSE OF MR. PAINE'S ASTRONOMICAL OBSERVATIONS.

Having given, in the preceding sections, a detailed statement of the methods used in obtaining the single results of the triangulation, and of the astronomical observations of Mr. Paine, I now proceed to furnish a comparison of the data obtained by the respective processes, in order to show at once the degree of precision of each, and their bearing on the standard values for the reduction of the triangulation, and on the question of the dimensions of the spheroid. The first step is to ascertain the value of the meridional degree, for some cardinal point of middle latitude. For this point I have selected the State House at Boston. I subjoin in a tabular form Mr. Paine's astronomical differences of latitude in arc, and the geodetic differences of latitude in feet, at the standard temperature, referred to the level of the sea.

No.	Names of Stations.	Mr. Paine's Latitude.	Middle Latitude.	Deg. of Meridian in English ft.
	Station of Comparison, Harris St. Church, Newburyport,	42° 48′ 32″.1		
1	Nantucket South Tower,	41 16 56 .0	42° 2′ 44″.05	364313.17
2	Holmes' Hole Windmill,	41 27 15 .3	42 7 53 .70	389.25
3	New Bedford Mariners' Church,	41 38 6 .3	42 13 19 .20	348.25
4	Barnstable Court House,	41 42 7 .3	42 15 19 .70	420.25
5	Sandwich Church,	41 45 31 .0	42 17 1 .55	357.10
	Station of Comparison, Salem East India Marine Hall,	42 31 18 .9		
6	Nantucket South Tower,	41 16 56 .0	41 54 7 .45	364253.76
7	Holmes' Hole Wind Mill,	41 27 15 .3	41 59 17 .10	340.59
8	New Bedford Church,	41 38 6 .3	42 4 42 .60	279.42
9	Sandwich Church,	41 45 31 .0	42 8 24 .95	274.76
10	Barnstable Court House,	41 42 7 .3	42 6 43 .10	447.68
	Station of Comparison, Highland Light, Cape Cod,	42 2 22 .2		
11	Nantucket South Tower,	41 16 56 .0	41 39 39 .10	364385.00
	Station of Comparison, St. Ann's Church, Lowell,	42 38 47 .6		
12	New Bedford Mariners' Church,	41 38 6 .30	42 8 26 .95	364236.76
	Station of Comparison, Gloucester Church,	42 36 44 .20		
13	Barnstable Court House,	41 42 7 .30	42 9 25 .75	364925.68
14	Nantucket South Tower,	41 16 56 .00	41 56 50 .10	594.00
15	New Bedford Mariners' Church,	41 38 6 .30	42 7 25 .25	738.33
	Station of Comparison, Harris St. Church, Newburyport,	42 48 32 .10		
16	Plymouth Court House,	41 57 28 .50	42 23 0 .30	364604.50

Rejecting the last four results in consequence of their difference from the mean, the others give the value of a degree of the meridian in English feet, at the several middle latitudes, as follows:

FIRST RESULT.

No.	Middle Latitude.	Length of Degree.
1)	42° 2′ 44″.05	364313.17 feet.
2)	42 7 53 .70	389.25
6)	41 54 7 .45	253.76
7)	41 59 17 .10	340.59
8)	42 4 42 .60	279.42
12)	42 8 26 .95	236.76
9)	42 8 24 .95	274.76
10)	42 6 43 .10	447.68
8)	336 32 19 .90	8) 2535.39
	42 4 2 .48	364317.00

SECOND RESULT.

No.	Middle Latitude.	Length of Degree.
3)	42° 13′ 19″.20	364348.25 feet.
4)	42 15 19 .70	420.25
5)	42 17 1 .55	357.10
	3) 45 40 .45	3) 1125.60
	42 15 13 .48	364375.20

THIRD RESULT.

11)	41 39 39 10	364385.00

In the absence of the necessary data, to reduce the values thus obtained to the same middle latitude, I referred for the occasion to the table in Rees's Cyclopædia, under the article Degree, which purports to give the value of meridional degrees of the terrestrial spheroid for every degree of latitude, supposing an ellipticity of $\frac{1}{3\,3\,4}$th of the equatorial radius; and which indicates fifty-seven feet as the increase in the value of the consecutive degrees, from the fortieth to the forty-third degree of latitude. Applying this increase, by arithmetical progression, to each of the foregoing values of the meridional degree, I inferred from them a value corresponding with the middle latitude forty-two degrees; and with the values thus reduced, and giving to each value a weight proportionate to the number of comparisons on which it was based, I obtained 364334 feet for the length of a degree whose middle latitude is 42°. The length of a degree perpendicular to the meridian, at the latitude of the Boston State House, was found from the convergency of the meridians to be 365511.33 feet, which value also was adopted. Its accuracy was tested by applying the results of trigonometrical measurement to the differences of longitude ascertained by Mr. Paine's chronometrical observations. The following values of degrees perpendicular to the meridian were attained in the same manner.

		Feet.
1)	From Boston State House and Northampton Church,	365177.60
2)	" " " " and Plymouth Court House,	365653.00
3)	" " " " and Amherst College Chapel,	365025.00
4)	" Springfield Court House and Plymouth Court House,	365888.43
5)	" " " " and Highland Light, Cape Cod,	365984.43
6)	" Greenfield Church and Gloucester Church,	365420.76
7)	" Boston State House and Pittsfield Church,	364193.11
8)	" Plymouth Court House and " "	364796.00
9)	" Boston State House and Williamstown Church,	364519.42
	Sum of the first 6 results,	6) 3149.22
	Mean of the first 6 results,	365525.00

The last three of these results are rejected on account of their discrepancy from the mean. The astronomical observations for determining the longitude at Pittsfield and Williamstown are supposed to have been affected by mountain attraction; and I have adopted the value of the degree perpendicular to the meridian, as derived from the incli-

nation of the meridians, in preference to the mean result given by this last table, in consequence of the discrepancies among its single results.

With the values of the meridional and perpendicular degrees thus found, I calculated the equatorial radius, polar semi-axis, and ellipticity of the terrestrial spheroid, and the differences in value of the meridional degrees of 41° 21′ 30″, 42° 21′ 30″, and 43° 21′ 30″. The results are as follows:—

Meridional degree for the latitude of the State House, 364356 feet.
Perpendicular degree for the same latitude, 365511 feet.
Equatorial radius, 20914728 feet = 3961.123 miles.
Polar semi-axis, 20854128 feet = 3949.646 miles.
Ellipticity, $\frac{1}{345}$ nearly of the equatorial radius.*
Length of meridional degrees, the latitude of whose middle point corresponds to

	Feet.	Difference.
41° 21′ 30″	= 364300.96	
		+ 55.04 feet.
42 21 30	= 364356.00	
		+ 55.22 "
43 21 30	= 364411.22	

From the calculated differences in the value of these meridional degrees, it was apparent that the increase of 57 feet to the degree, which I had adopted when preparing to deduce the value of the meridional degree from a combination of my proximate results, was not strictly accurate. But as the effect of the resulting error would scarcely have been appreciable, I did not deem it necessary to recalculate the work.

With the data already mentioned, I proceeded to determine the latitude of a *Cardinal* point, namely, the State House at Boston, by comparison with several of the principal stations, as follows:—

No.	Place compared with Boston State House.	Resulting Latitude of Boston State House.
1)	New Bedford Mariners' Church,	42° 21′ 29″.84
2)	Harris Street Church in Newburyport,	29 .95
3)	Salem East India Marine Hall,	30 .38
4)	Saint Ann's Church in Lowell,	30 .82
5)	Barnstable Court House,	31 .23
6)	Sandwich Church in Sandwich,	29 .91
7)	Highland Lighthouse, Cape Cod,	28 .84
8)	Nantucket South Tower,	29 .38
9)	Holmes' Hole Windmill,	30 .43
		9) 270 .78
	Mean latitude of the State House,	42° 21′ 30″.08
	Mr. Paine's Astronomical Result,	42 21 23 .03
	Discrepancy,	7″.05

The results arrived at from these data, on the final reduction of the triangles of the survey, using for the latitude of the State House 42° 21′ 30″, and for its longitude, that which is given by Mr. Paine, $4^h\ 44^m\ 16^s.6$ west of Greenwich, are compared with the

* Combining the meridional degree measured in Peru, in latitude 1° 30′, with the meridional degree measured in Massachusetts, they give an ellipticity of 1-313th nearly of the equatorial radius.

results of the chronometrical survey of Mr. Paine, in the following tables; which exhibit, also, the number of altitudes of the sun and north and south stars taken by Mr. Paine in determining the latitude of each station, and the number of journeys made by him with chronometers, and of the chronometers used by him on such journeys, in ascertaining its longitude.

Latitudes.

No.	Place in which Station is situated.	Name of Station.	Altitudes observed.	Paine's Latitudes.	Paine, north of Borden.
1	Boston,	State House,	442	42° 21′ 22″.70	— 7″.00
2	Amherst,	College Chapel,	109	42 22 12 .60	— 3 .01
3	Barnstable,	New Court House,	267	41 42 7 .30	+ 1 .23
4	Cambridge,	1st Congregational Church,	201	42 22 21 .30	— 7 .81
5	Dedham,	" " "	198	42 14 52 .30	— 5 .00
6	Greenfield,	2d " "	169	42 35 16 .30	+ 1 .50
7	Gloucester,	1st Independent Church,	113	42 36 44 .20	— 3 .97
8	Holmes' Hole,	Windmill west of Village,	174	41 27 15 .30	+ 0 .43
9	Lowell,	St. Ann's Church,	300	42 38 47 .60	+ 0 .82
10	Monomoy Point,	Light House,	156	41 33 30 .80	— 4 .20
11	Nantucket,	South Tower Ch.,	260	41 16 56 .00	— 0 .62
12	New Bedford,	Mariners' Church,	322	41 38 6 .30	— 0 .16
13	Newburyport,	Harris Street Church,	202	42 48 32 .10	— 0 .05
14	Northampton,	1st Congregational Church,	327	42 19 8 .00	— 1 .09
15	Pittsfield,	" " "	210	42 26 55 .00	— 0 .59
16	Plymouth,	Court House,	169	41 57 28 .50	+ 1 .94
17	Providence, R. I.,	University Hall,	308	41 49 31 .90	— 2 .58
18	Salem,	East India Marine Hall,	154	42 31 18 .90	+ 0 .38
19	Sandwich,	1st Congregational New Unitarian Church,	139	41 45 31 .00	— 0 .09
20	Springfield,	Court House,	168	42 6 1 .20	— 2 .41
21	Taunton,	Trinitarian Church,	181	41 54 8 .30	— 2 .98
22	Truro,	Cape Cod Lights,	228	42 2 22 .20	— 1 .16
23	Williamstown,	Congregational Church near College,	110	42 42 50 .60	+ 1 .53
24	Worcester,	Antiquarian Hall,	351	42 16 12 .60	— 4 .44
25	Squam,	Light,	38	42 39 46 .08	+ 2 .53
26	Cape Ann,	N. Light, Thatcher's Island,	39	42 38 18 .00	— 3 .78
27	Eastern Point,	Light,	36	42 34 48 .00	— 1 .61
28	Baker's Island,	Light,	64	42 32 11 .40	— 0 .62
29	Hartford, Conn.,	State House,	23	41 45 59 .10	+ 0 .96
30	Cambridge,*	Harvard Observatory Transit,	N. of Boston State House,		52″.26
31	Dorchester,*	Bond's Transit. Ins.	S. of " " "		2′ 13 .41
32	Southwick,*	Holcomb's House,	S. of Springfield C. H.,		5 13 .91

Longitudes.

No.	Place in which Station is situated.	Journeys with Chronometers.	No. of Chronometers used.	Paine's Longitudes.	Paine, west of Borden.
1	Boston,			71° 4′ 9″.00	+ 0″.00
2	Amherst,	9	25	72 31 35 .85	+ 7 .36
3	Barnstable,	18	59	70 18 36 .00	+ 2 .19
4	Cambridge,	6	20	71 7 38 .10	+ 9 .25
5	Dedham,	7	23	71 10 49 .20	— 10 .08
6	Greenfield,	6	14	72 36 31 .95	+ 4 .75
7	Gloucester,	16	60	70 40 19 .05	+ 1 .88
8	Holmes' Hole,	10	36	70 36 37 .80	+ 0 .22
9	Lowell,	14	34	71 18 57 .30	— 4 .74
10	Monomoy Point,	2	10	70 0 5 .40	+ 9 .16

* NOTE BY THE COMMITTEE.—Nos. 30, 31, and 32 are according to Mr. Borden's survey, not having been principal stations of Mr. Paine. Their connexion with the survey is important, from their being the site of a series of independent astronomical observations by Mr. Bond and Mr. Holcomb, which, when reduced, will further test the precision of the two methods employed by Messrs. Paine and Borden.

No.	Place in which Station is situated.	Journeys with Chronometers.	No. of Chronometers used.	Paine's Longitudes.	Paine, west of Borden.
11	Nantucket,	10	28	70° 6′ 12″.15	— 1 .73
12	New Bedford,	18	54	70 55 49 .35	+ 4 .96
13	Newburyport,	16	46	70 52 47 .10	+ 5 .80
14	Northampton,	24	74	72 38 21 .00	+ 6 .06
15	Pittsfield,	13	39	73 16 5 .10	+ 28 .98
16	Plymouth,	10	33	70 40 27 .60	+ 8 .33
17	Providence, R. I.,	11	40	71 24 48 .00	+ 13 .59
18	Salem,	14	42	70 53 56 .70	+ 3 .67
19	Sandwich,	13	38	70 30 27 .00	+ 13 .81
20	Springfield,	16	51	72 35 47 .25	+ 2 .31
21	Taunton,	12	36	71 6 4 .50	+ 9 .47
22	Truro,	7	24	70 4 8 .70	+ 13 .37
23	Williamstown,	10	28	73 13 19 .50	+ 19 .24
24	Worcester,	15	45	71 48 10 .20	— 2 .84
25	Squam,	2	14	70 41 8 .00	— 4 .33
26	Cape Ann,	2	14	70 34 44 .00	— 4 .05
27	Eastern Point,	By bearing from Gloucester Point.		70 40 12 .75	+ 1 .90
28	Baker's Island,	2	14	70 47 37 .00	+ 8 .59
30	Cambridge,*	West of State House, Boston, . . .		3 6 .42	
31	Dorchester,*	West of " " " . . .		11 .24	
32	Southwick,*	West of Springfield Court House, . .		12 59 .86	

Comparison of the latest elements of the spheroid obtained by Bessel, from the mean of the ten surveys hitherto executed, (see Astr. Nachr., No. 438,) with those derived by me from the triangulation of Massachusetts, combined with Mr. Paine's differences of latitude and longitude.

Elements.	Values from Bessel's Elements.	Borden's values from the Map Survey.	Discrepancy.
Equatorial radius in English feet, - - - -	20923597.14	20914728.00	
" " " miles, - - -	3962.803	3961.123	1.68 miles.
Polar semi-axis in English feet, - - - -	20853657.16	20854128.00	
" " " miles, - - - -	3949.556	3949.646	0.09 miles.
Degree of the meridian for lat. 42° 21′ 30″ in feet,	364403.28	364356.00	47.28 feet.
Degree of the perpendicular to the meridian do. do.	365740.21	365511.33	228.88 feet.
Degree of the parallel for lat. 42° 21′ 30″ do. do.	270262.09	270092.12	169.97 feet.
Latitude of the southernmost point Nantucket, - -	41° 16′ 57″.19	41° 16′ 56″.62	0″.57
Latitude of the northernmost point Newburyport -	42° 48′ 32″.00	42° 48′ 32″.15	0″.15

The comparison of Mr. Paine's differences of longitude by chronometers with those of the triangulation, reduced respectively by Bessel's latest elements of the spheroid, and those obtained from the Massachusetts survey, gives the following results for the several stations, referred to the Boston State House.

No.	Station.	Paine West of Borden in time.	Borden West of Bessel in time.	No.	Station.	Paine West of Borden in time.	Borden West of Bessel in time.
1	Boston,	0.ˢ00	0.ˢ00	15	Pittsfield,	+ 1.ˢ93	+ 0.ˢ33
2	Amherst,	+ 0. 49	+ 0. 22	16	Plymouth,	+ 0. 56	— 0. 06
3	Barnstable,	+ 0. 15	— 0. 12	17	Providence,	+ 0. 91	+ 0. 05
4	Cambridge,	+ 0. 62	+ 0. 01	18	Salem,	+ 0. 24	— 0. 02
5	Dedham,	— 0. 67	+ 0. 02	19	Sandwich,	+ 0. 92	— 0. 08
6	Greenfield,	+ 0. 31	+ 0. 23	20	Springfield,	+ 0. 15	+ 0. 23
7	Gloucester,	+ 0. 13	— 0. 05	21	Taunton,	+ 0. 63	+ 0. 00
8	Holmes' Hole,	+ 0. 01	— 0. 06	22	Truro—Highland Light,	+ 0. 89	— 0. 15
9	Lowell,	— 0. 32	+ 0. 03	23	Williamstown,	+ 1. 28	+ 0. 32
10	Monomoy Light,	+ 0. 61	— 0. 16	24	Worcester,	— 0. 19	+ 0. 11
11	Nantucket,	— 0. 11	— 0. 14	25	Squam Light,	— 0. 29	— 0. 05
12	New Bedford,	+ 0. 33	— 0. 02	26	Thacher's Island Light,	— 0. 27	— 0. 07
13	Newburyport,	+ 0. 39	— 0. 03	27	Eastern Point Light,	+ 0. 13	— 0. 05
14	Northampton,	+ 0. 40	+ 0. 24	28	Baker's Island Light,	+ 0. 57	— 0. 04

* See note on preceding page.

In consequence of a remark of Mr. Hassler, that differences of longitude obtained by transportation of chronometers do not possess the requisite precision for determining the elements for the reduction of the triangulation, and are consequently unfit for geodetic purposes, I was induced to compare the results derived from all the chronometric differences of longitude, which, according to the plan pursued, would produce a weight worth noticing, (except Williamstown and Pittsfield stations, which stations, as I have before noticed, are presumed to be affected by a deflection of the plumb line,) with Bessel's latest mean result from the ten trigonometric surveys hitherto executed. For this purpose, I first ascertained that the meridians of the Massachusetts survey were sufficiently accurate, since a change in their convergency of — 2″.94, in latitude 42° 21′ 30″, for a difference of longitude of 1° 58′ 30″.27, would fit them to Bessel's elements. I then proceeded to compute the value of the degree perpendicular to the meridian for the latitude of the State House at Boston, (namely, 42° 21′ 30″,) by means of Mr. Paine's longitudes of the principal stations, which were obtained directly from the State House, and omitting those intermediate stations which were not directly compared therewith, excepting Nantucket, which, by Mr. Paine's report, appears to have been compared directly with New Bedford. But, as I have presumed there might exist a difference of opinion respecting Nantucket, that is, whether it should be compared with Boston or New Bedford, I have compared it with both, and have taken a mean of the results; presuming, further, that Mr. Paine frequently hastened his journey as rapidly as possible from Boston to Nantucket, and from Nantucket to Boston, by the way of New Bedford, and that therefore both comparisons would be equally entitled to consideration. Throughout the whole of these comparisons a relative weight, proportionate to the polar angle subtended, has been given to each value obtained.

No.	Stations compared.	Degree perpendicular to the Meridian in feet.	Relative Weight.	Product in Feet.
		D.	W.	D × W.
1	Boston and Northampton, . . .	365119	1.00	365119
2	" " Springfield, ...	365356	0.97	354395
3	" " Greenfield, ...	365198	0.98	357894
4	" " Worcester, ...	365904	0.47	171976
5	" " Barnstable, ...	365804	0.48	175586
6	" " Gloucester, ...	365991	0.25	91498
7	" " Monomoy, ...	366382	0.68	249140
8	" " Plymouth, ...	367653	0.25	91913
9	" " Truro, ...	366897	0.64	234814
10	" " Nantucket, ...	365329	0.62	226504
		Aggregate,	6.34	2318839
		Paine's mean value,		365747

By comparing the Nantucket station with New Bedford, the tenth result becomes 364690 feet, with a weight of 0.52. This, substituted for No. 10 in the table, gives a mean result 365701, which, added to the result before obtained, and divided by 2, gives 365724 feet for the value of the perpendicular degree. This value I have adopted in computing the succeeding elements, which are compared, in the following table, with corresponding elements obtained by Bessel.

Elements.	Values from Bessel's Elements.	Borden's Values from the Massachusetts Survey.	Discrepancy.
Equatorial radius in English feet, ...	20923597.14	20921935.54	
" " " " miles, ...	3962.803	3962.487	0.316 miles
Polar semi-axis in English feet.	20853657.16	20850374.32	
" " " " miles.	3949.556	3948.935	0.621 miles
Degree of the meridian for latitude 42° 21′ 30″ in feet,	364403.28	364356.00	47.28 feet
Degree perpendicular to meridian for do. do. do.	365740.21	365724.00	16.21 feet
Degree of the parallel for latitude 42° 21′ 30″ do.	270262.09	270250.10	12.00 feet
Ellipticity, ...	$\frac{1}{299}$	$\frac{1}{292}$	$\frac{1}{007}$

The conclusion from this examination is, that chronometric comparisons do afford the means of determining one of the elements of the reduction of a trigonometric survey, namely, the value of a degree perpendicular to the meridian, and that, too, with a degree of uniformity quite too great to be the result of a happy accident.

Note by the Committee.—Mr. Boutelle informs the Committee that Rittenhouse, in tracing the boundary between Massachusetts and New York, had determined his course in such a manner as to agree with that of the Massachusetts survey within 7″, and that his latitude differed from theirs only 5″.

ARTICLE III.

Observations on Egyptian Ethnography, derived from Anatomy, History, and the Monuments. By Samuel George Morton, M. D. Read December 16, 1842; *January* 6, *and April* 6, 1843.

INTRODUCTORY REMARKS.

Egypt is justly regarded as the parent of civilization, the cradle of the arts, the land of mystery. Her monuments excite our wonder, and her history confounds chronology; and the very people who thronged her cities would be unknown to us, were it not for those vast sepulchres whence the dead have arisen, as it were, to bear witness for themselves and their country. Yet even now, the physical characteristics of the ancient Egyptians are regarded with singular diversity of opinion by the learned, who variously refer them to the Jews, Arabs, Hindoos, Nubians, and Negroes. Even the details of organic structure have been involved in the same uncertainty,—the configuration of the head, the position of the ear, the form of the teeth, the colour of the skin, and the texture of the hair; while the great question is itself undetermined—whether civilization ascended or descended the Nile;—whether it had its origin in Egypt or in Ethiopia. These conflicting opinions long since made me desirous to investigate the subject for myself; but the many difficulties in the way of obtaining adequate materials, compelled me to suspend the inquiry; and it is only within a recent period that I have been able effectively to resume it. It gives me great pleasure to state, that my present facilities have been almost exclusively derived, directly or indirectly, from the scientific zeal and personal friendship of George R. Gliddon, Esq., late United States consul for the city of Cairo. During a former visit to the United States, this gentleman entered warmly into my views and wishes; and on his return to the East, in 1838, he commenced his researches on my behalf; and in the course of his various travels in Egypt and in Nubia, as far as the second Cataract, he procured one hundred and thirty-seven human crania, of which one hundred pertain to the ancient inhabitants of Egypt. Of these last, seventeen were most obligingly sent me, at the instance of Mr. Gliddon, by M. Clot Bey, the distinguished Surgeon in chief to the Viceroy of Egypt. They are arranged by the latter gentleman into two series, the Pharaonic, and the Ptolemaic; but without availing myself of this classification, I have merely regarded them in reference to their national characters.

Mr. Gliddon's residence for the greater part of twenty-three years in Egypt, and his

varied official and other avocations, together with his acquaintance with the people, and their languages, have given him unusual facilities for collecting the requisite materials; while their authenticity is amply vouched for by one who blends the character of a gentleman with the attainments of a scholar.

The object of this memoir, therefore, will be to throw some additional light on the questions to which I have adverted, and to ascertain, if possible, the Ethnographic characters of the primitive Egyptians; or, in other words, to point out their relative position among the races of men.

It is necessary, however, to premise, that the materials in my possession, were collected without the slightest bias of opinion on the part of Mr. Gliddon, who, at the period in question, had paid no particular attention to Ethnography; and indeed very many of these crania were received by me in their original wrappings, which were first removed, after the lapse of ages, by my own hands.

It is farther requisite to bear in mind, that, with a few exceptions I have no clew whatever, whereby to ascertain or even to conjecture, the epoch to which these remains have belonged. The Egyptian catacombs do not always contain their original occupants; for these were often displaced and the tombs re-sold for mercenary purposes: whence it happens, that mummies of the Greek and Roman epochs, have been found in those more ancient receptacles which had received the bodies of Egyptian citizens of a far earlier date. The bodies thus displaced, however, *were not destroyed;* and the Egyptians of at least twenty-five centuries before our era, though for the most part mingled without regard to rank or epoch, are still preserved in their interminable cemeteries.

I disclaim all knowledge of hieroglyphic literature; but I may express my conviction that the past discoveries and pending researches of Young, Champollion, Rosellini, Wilkinson, Lepsius, and some other illustrious men, are destined to unravel all that has hitherto been regarded as mystical in Egyptian history; while the invaluable disclosures which they have already made, entitle them to the lasting gratitude of the student of Archæology.

A few words in reference to chronology. Rosellini places the accession of the XVI. dynasty of Egyptian kings at 2272 years before Christ. Champollion adopts a nearly similar arrangement. The learned Dr. Wiseman admits that there are monuments in Egypt as old as 2200 years before our era; and Dr. Prichard dates the accession of Menes two centuries earlier in time. The veneration with which all these authors regard the sacred writings, has given me the greater confidence in their opinions, which I therefore adopt in general for the distant landmarks of time; and in respect to later and subordinate dates, I have been governed exclusively by the published system of Professor Rosellini, which is regarded by competent judges as more complete than any other.

I have great pleasure in stating, that for the unrestricted use of the first copy of Rosellini's splendid work which was brought to the United States, I am indebted to an accomplished traveller, Richard K. Haight, Esq., of New York; a gentleman who devotes his leisure hours and opulent income to the promotion of archæological knowledge.

To John Gliddon, Esq., United States consul at Alexandria, to the Rev. George W. Bridges, and to M. E. Prisse, now in Egypt, I also take this occasion to express my sincere acknowledgments for the practical zeal with which they have aided my researches.

I have been enabled to make extensive and satisfactory comparisons by means of nearly six hundred human crania, which form a part of my private anatomical collection. The numbers in brackets refer to corresponding numbers on the skulls themselves, and in my printed catalogue; and will serve as a future test of the accuracy of my observations, which, embracing as they do, such a multitude of details, may require some revision and correction.

How far the following observations may assist in solving a problem which, until lately, has been clothed in equal obscurity and interest, is not for me to determine; but I trust they will at least, have the effect of inciting others to researches of a similar nature.

EGYPTIAN ETHNOGRAPHY.

"Vix quidem monitu opus est in tanta seculorum serie qua mos cadavera balsamo condiendi in Ægypto solemnis fecit, inque tam variorum ejus terræ dominorum et incolarum vicissitudine magnam mumias intercedere debere variatatem tam quod ad condituræ variam rationem et materiem; quam quod ad craniorum in mumiis gentilitiam formam et speciem." —BLUMENBACH, *Decad. Cran.* p. 12.

It was remarked fifty years ago by the learned Professor Blumenbach, that a principal requisite for an inquiry such as we now propose, would be "a very careful, technical examination of the skulls of mummies hitherto met with, together with an accurate comparison of these skulls with the monuments." This is precisely the design I have in view in the following memoir, which I therefore commence by an analysis of the characters of all the crania now in my possession. These may be referred to two of the great races of men, the CAUCASIAN and the NEGRO, although there is a remarkable disparity in the number of each. The Caucasian heads also vary so much among themselves as to present several different types of this race, which may, perhaps, be appropriately grouped under the following designations:—

CAUCASIAN RACE.

1. The **Pelasgic Type.* In this division I place those heads which present the finest conformation, as seen in the Caucasian nations of western Asia, and middle and southern Europe. The Pelasgic lineaments are familiar to us in the beautiful models of Grecian art, which are remarkable for the volume of the head in comparison with that of the face, the large facial angle, and the symmetry and delicacy of the whole osteological structure. Plate III., Fig. 6, and Plate X., Fig. 8, are among the many examples of this conformation.

2. The *Semitic Type*, as seen in the Hebrew communities, is marked by a comparatively receding forehead, long, arched, and very prominent nose, a marked distance between the eyes, a low heavy broad, and strong and often harsh development of the whole facial structure. Plate XI., Fig. 2.

* I do not use this term with ethnographic precision; but merely to indicate the most perfect type of cranio-facial outline.

3. The *Egyptian* form differs from the Pelasgic in having a narrower and more receding forehead, while the face being more prominent, the facial angle is consequently less. The nose is straight or aquiline, the face angular, the features often sharp, and the hair uniformly long, soft, and curling. In this series of crania I include many of which the conformation is not appreciably different from that of the Arab and Hindoo; but I have not, as a rule, attempted to note these distinctions, although they are so marked as to have induced me, in the early stage of the investigation, and for reasons which will appear in the sequel, to group them, together with the proper Egyptian form, under the provisional name of *Austral-Egyptian* crania. I now, however, propose to restrict the latter term to those Caucasian communities which inhabited the Nilotic valley *above* Egypt. Among the Caucasian crania are some which appear to blend the Egyptian and Pelasgic characters: these might be called *Egypto-Pelasgic* heads; but without making use of this term, except in a very few instances by way of illustration, I have thought best to transfer these examples from the Pelasgic group to the Egyptian, inasmuch as they so far conform to the latter series as to be identified without difficulty. For examples of this mixed form, I refer especially to Plate XI., Fig. 1, and Plate III., Fig. 7.

NEGRO RACE.

The true *Negro* conformation requires no comment; but it is necessary to observe that a practised eye readily detects a few heads with decidedly mixed characters, in which those of the Negro predominate. For these I propose the name of *Negroid* crania; for while the osteological development is more or less that of the Negro, the hair is long but sometimes harsh, thus indicating that combination of features which is familiar in the mulatto grades of the present day. It is proper, however, to remark in relation to the whole series of crania, that while the greater part is readily referrible to some one of the above subdivisions, there remain other examples in which the Caucasian traits predominate, but are partially blended with those of the Negro, which last modify both the structure and expression of the head and face.

We proceed, in the next place, to analyze these crania individually, arranging them, for the purpose of convenience, into seven series, according to their sepulchral localities, beginning with the Necropolis of Memphis in the north:

First series, from the Memphite Necropolis.

A. Pyramid of five steps.
B. Saccàra, generally.
C. Front of the Brick Pyramid of Dashour.
D. North-west of the Pyramid of Five Steps.
E. Toora, on the Nile.

Second series, from the Grottoes of Maabdeh.
Third series, from Abydos.
Fourth series, from the Catacombs of Thebes.
Fifth series, from Koum Ombos.
Sixth series, from the Island of Beggeh, near Philæ.
Seventh Series, from Debòd in Nubia.

FIRST SERIES.

TWENTY-SIX SKULLS FROM THE NECROPOLIS OF MEMPHIS.

This vast Necropolis extends from the Pyramids of Gizeh to the southern limit of Saccàra, a distance of about fifteen miles. The tombs are cut in the solid rock, and frequently communicate with one another, forming a vast subterranean labyrinth. Memphis is well known to be one of the oldest, if not indeed the oldest of the Egyptian cities; and among the tombs now extant Professor Rosellini has found some which bear inscriptions of a date nearly 2300 years before Christ, at which period Memphis must have been a large and flourishing city. The simpler catacombs were probably constructed before the pyramids; for these last could only result from centuries of civilization, and next to the catacombs, are the oldest existing monuments of the human race.

A.—FROM THE PYRAMID OF FIVE STEPS.

In the month of August, 1839, Mr. J. S. Perring, the distinguished Engineer, discovered a *fourth* entrance to this pyramid, which was found to communicate with a recess at the south-western corner of a large apartment described in his narrative. This communication is a horizontal gallery one hundred and sixty-six feet long, and the recess is seventy feet above the floor. "The southern end of the gallery," observes Colonel Vyse, "was stopped up with sand; but for the length of one hundred and sixty feet from the interior it was open, and did not seem to have been previously visited, as nearly thirty mummies were found in it apparently undisturbed. They had neither coffins nor sarcophagi, nor, with the exception of three or four, any painted decorations. They crumbled to pieces on being touched, and could not be removed. Mr. Perring, therefore, proceeded to examine them. He found them enclosed in wrappers, with pitch and bitumen; but he did not meet with any of the objects usually deposited with mummies, excepting some of the common stone idols upon the body of the female. He therefore concluded that they were the bodies of persons employed in the building."*

Fortunately for my inquiries, Mr. Gliddon was at hand when these relics were brought to light, and obtained them of Mr. Perring as a contribution to my researches. With the utmost care on Mr. Gliddon's part, two of three reached me in safety, but the third was broken into numberless fragments. In fact, the consistence of these bones is but little firmer than unbaked clay, and the animal matter is nearly obliterated. If Mr. Perring's opinion be correct, that the persons to whom these bodies belonged were coeval with the construction of the pyramid, we may with safety regard them as the most ancient human remains at present known to us. Whether, as that gentleman suggests, they pertained to workmen employed in building the pyramid, I will not pretend to decide; but although they present indifferent intellectual developments, their conformation is that of the Caucasian race.

Plate I., Fig. 1. (Cat. 838.) An oval head with a broad but rather low forehead, moderately elevated vertex, and full occiput. The superciliary ridges are prominent, the orbits oblong-oval, the nasal bones large, salient and aquiline, the teeth vertical

* Explorations at the Pyramids, Vol. III., p. 44.

and the whole facial structure delicate. The head of a woman of about forty years.*—I. C. 90 cubic inches. F. A. 81°. *Pelasgic form.*

Plate I., Fig. 2. (Cat. 837.) A large and ponderous skull, with a broad but low forehead, and very prominent superciliary ridges. The vertex is elevated, the occipital region remarkably full, and the parietal diameter large. The bones of the face are delicately formed, the nose long and aquiline, the orbits rounded, the teeth vertical.—I. C. 97 cubic inches. F. A. 83°. *Pelasgic form.*

This is the skull of a man who may have reached his fiftieth year. The teeth are much worn, and parts of the sutures nearly obsolete. This person, long antecedent to his death, had received a severe wound over the right orbit, beginning at the nasal bone and extending upwards and outwards nearly two inches, fracturing and depressing both tables of the skull. The consequent deformity is manifest, although the cicatrization is complete.

B.—FROM THE MEMPHITE NECROPOLIS.

Eleven skulls from various mummy pits in the great Necropolis of Saccàra. In Mr. Gliddon's memoranda he remarks that these heads were mostly taken from the mummies themselves, and from the best constructed pits; and that having been enclosed in coffins painted and otherwise ornamented with different degrees of care, they probably pertained to the higher class of Egyptians.

Plate II., Fig. 1. (Cat. 808.) A large elongate-oval head, with a broad, high forehead, low coronal region, and strongly aquiline nose. The orbits nearly round; teeth perfect and vertical.—I. C. 97 cubic inches. F. A. 77°. *Pelasgic form.*

Plate II., Fig. 2. (Cat. 815.) A beautifully formed head, with a forehead high, full, and nearly vertical, a good coronal region, and largely developed occiput. The nasal bones are long and straight, and the whole facial structure delicately proportioned. Age, between thirty and thirty-five years.—I. C. 88 cubic inches. F. A. 81°. *Pelasgic form.*

Plate II., Fig. 3. (Cat. 812.) Skull of a woman of twenty years? with a beautifully developed forehead, and remarkably thin and delicate structure throughout. The frontal suture remains.—I. C. 82 cubic inches. F. A. 80°. *Pelasgic form.*

Plate II., Fig. 4. (Cat. 806.) A thin cranium, of a short-oval form; the forehead is broad, the coronal region low, and the whole face prominent. Age, about thirty years. I. C. 83 cubic inches. F. A. 77°. *Egyptian form.*

Plate II., Fig. 5. (Cat. 814.) Cranium of a man of eighty or ninety years, with a full but rather receding forehead, and strongly developed cranial structure.—I. C. 97 cubic inches. *Pelasgic form.*

Plate II., Fig. 6. (Cat. 810.) An admirable conformation, as seen in the broad, high forehead, full occiput, and gently aquiline nose. Probably a female of twenty years.—I. C. 86 cubic inches. F. A. 78°. *Egyptian form?*

Plate II., Fig. 7. (Cat. 805.) A narrow, elongated head, with an indifferent frontal region. A man of fifty?—I. C. 79 cubic inches. F. A. 83°. *Pelasgic form.*

* The letters I. C., denote the internal capacity of the cranium.—F. A., the Facial Angle. The skulls of persons under sixteen or eighteen years of age are seldom measured, and never admitted into the computations of this memoir.

Plate II., Fig. 8. (Cat. 807.) A large, thin, oval cranium, with a broad, receding forehead, tumid occiput, a long and very aquiline nose, and remarkably prominent face. The frontal suture remains entire. Probably a man of thirty years.—I. C. 88 cubic inches. F. A. 74°. *Semitic form.*

Plate III., Fig. 2. (Cat. 809.) A female head, with a somewhat receding forehead and low coronal region.—I. C. 81 cubic inches. F. A. 78°. *Egyptian form.*

Plate III., Fig. 1. (Cat. 811.) A small head, with a narrow frontal region, receding forehead, and broad parietal diameter. A female? of about twenty-five years.—I. C. 73 cubic inches. F. A. 76°. *Egyptian form.*

(Cat. 813.) Skull of a child of eight years, with a finely developed forehead, tumid occiput and full facial angle. *Pelasgic form.*

C.—FROM THE FRONT OF THE NORTHERN BRICK PYRAMID OF DASHOUR.

Three skulls exhumed by Mr. Perring from the above mentioned locality in the Memphite Necropolis. They were discovered in the month of August, 1839, in the process of trenching to find an entrance to the pyramid. The following extract from Col. Vyse's admirable work embraces all the information we possess in relation to these remains, merely premising that none of the *mummied* heads alluded to has come into my possession.

"At the depth of about four feet six inches, above fifty bodies were found, ten of which were mummies, embalmed and deposited in the usual manner. The others were much decayed, and had been buried in their clothes, and in some instances were bound round with common cord and laid in wooden coffins, or among a few branches of date trees. Some of the clothes were woollen, others coarse linen, with a fringed border of bright scarlet worsted. The heads were covered with bright red network. Mr. Perring imagined that these bodies had belonged to a pastoral people, probably to Bedouins, and that they had been interred, together with the mummies, at a very early period, before the introduction of Christianity." Vyse, Pyramids, III., p. 60.

These crania, which are remarkably small, possess much of the Egyptian form, and are well represented in the following outlines.

(Cat. 795.) An oval cranium with a receding forehead, full coronal region, strongly developed upper maxilla, and prominent face.—I. C. 75 cubic inches. F. A. 76°.—*Egyptian* blended with the *Negroid form?*

(Cat. 796.) A small oval head, low forehead, and salient and very aquiline nose. Fa-

cial bones thin and delicately proportioned.—I. C. 80 cubic inches. F. A. 75°. *Egyptian form.*

(Cat. 797.) A small, thin, irregularly formed head, with a full forehead and salient nose. The alveoli are absorbed by age. A woman of 70 years?—I. C. 76 cubic inches. *Egyptian form.*

D.—FROM THE NECROPOLIS OF MEMPHIS, NORTH-WEST OF THE PYRAMID OF FIVE STEPS.

Nine skulls of mummied Egyptians, taken by Mr. Gliddon from a large pit which had just been opened by the Arabs. Mr. G. remarks that No. 803 is a male, and 804 a female, both unwrapped by his own hands. "These mummies were all of a superior order, and enclosed in wooden cases. The pit was opened in my presence, and consisted of a deep shaft cut through the solid rock, with two or three chambers filled with undisturbed mummies."

Scarcely any integuments remain on these heads, the removal of the wrappings leaving the bone for the most part completely denuded.

Plate III., Fig. 3. (Cat. 804.) A remarkably beautiful female head, not exceeding the age of twelve years. *Pelasgic form.*

Plate III., Fig. 4. (Cat. 799.) A ponderous skull, with a fine frontal, and full coronal region. Probably a man of 35 years.—I. C. 87 cubic inches. F. A. 82°. *Pelasgic form.*

Plate III., Fig. 5. (Cat. 816.) A beautifully oval and finely arched cranium, with a high, prominent forehead, tumid occiput, aquiline nose, and oblong orbitar cavities. A man of 45?—I. C. 92 cubic inches. F. A. 78°. *Pelasgic form.*

Plate III., Fig. 6. (Cat. 798.) A delicately proportioned and finely arched head. The cheek bones are small, and the nose strongly aquiline. Age, about 45 years.—I. C. 84 cubic inches. F. A. 80°. *Pelasgic form.*

Plate III., Fig. 7. (Cat. 802.) A finely developed cranium, with a delicate, but rather prominent face, and strongly arched nose. Probably a female of 50 years.—I. C. 81 cubic inches. *Egypto-Pelasgic form.*

Plate III., Fig. 8. (Cat. 803.) A large, oval head, with a broad, receding forehead, low coronal region, and salient nose. A man of 45 or 50 years.—I. C. 92 cubic inches. F. A. 82°. *Pelasgic form.*

(Cat. 800.) Skull of a child of 10 years, with a receding forehead, narrow, projecting face, and salient teeth. *Negroid form.*

(Cat. 801.) A juvenile head, heavy, but beautifully proportioned, especially in the frontal region. *Pelasgic form.*

Plate III., Fig. 9. (Cat. 825.) A large and remarkably intellectual head, of the finest proportions throughout. The hair is in part preserved, and is long, smooth and of a dark brown colour.—I. C. 93 cubic inches. F. A. 81°. *Pelasgic form.*

E.—FROM TOORA, ON THE NILE.

Plate II., Fig. 9. (Cat. 840.) Skull of a man from the ancient quarries at Toora, opposite Memphis, on the east bank of the Nile, about seven miles above Cairo. From

this place the stones were obtained for building the Pyramids of Gizeh, and many later structures, down to the epoch of the Ptolemies. Mr. Gliddon was present at the exhumation of several of these crania, yet, owing to their extremely fragile state, but one reached me in safety, and for this I am indebted to the kindness of Mr. Mash. They were found in rude sarcophagi of limestone, and wrapped in coarse matting. These remains, which were discovered in 1837-38, are supposed to have pertained to the master-quarrymen.

The head figured is of an elongated oval form, with a moderate frontal development and low coronal region. The nose is strongly salient and aquiline, and the whole cranial structure thin and delicate.—I. C. 89 cubic inches. F. A. 79°. *Pelasgic form.*

Remarks on the preceding series of Crania.—A mere glance at this group of skulls will satisfy any one accustomed to comparisons of this kind, that most of them possess the Caucasian traits in a most striking and unequivocal manner, whether we regard their form, size, or facial angle. It is, in fact, questionable whether a greater proportion of beautifully moulded heads would be found among an equal number of individuals taken at random from any existing European nation. The entire series consists of sixteen examples of the Pelasgic and seven of the Egyptian form, a single Semitic head, one of the Negroid variety, and one of mixed conformation. Of the antiquity of these remains there can be no question; and with respect to a part of them, those from the Pyramid of Five Steps, we have evidence of a more precise character.

These most ancient mummies appear to have been prepared with but little bitumen, and to have undergone desiccation by some primitive and simple process of embalming; such, for example, as first saturating the body in natron, and then subjecting it to heat in an oven. It is also to be remarked, that in these two heads the brain has not been removed through the nostrils, according to the general custom, for the ethmoid bone is unbroken; and the cranial contents could therefore only have been withdrawn through the foramen magnum at the base of the skull.

This last remark also applies to sixteen other heads of this series; whence I was at first led to suppose that they could not pertain to a very remote epoch. But when we find that the oldest remains are similarly characterized, and bear in mind that the removal of the brain through the nose was a conventional part of the more perfect art of embalming, may we not suppose that this imperforate state of the cranium points to an early epoch of Egyptian history, before mankind had resorted to those elaborate methods of preserving the dead body which are so remarkable in the *Theban* catacombs? It has been conjectured that the proximity of the Natron Lakes to the city of Memphis gave rise to the custom of embalming; and it is not an improbable supposition that the profuse employment of bitumen was a subsequent refinement of the art. This suggestion derives some support from another fact; namely, that in every instance in which I have observed the brain to have been removed through the nose, the bones and integuments are much more charged with bitumen than in the imperforate crania.

It may, perhaps, be conjectured by some that the Pelasgic heads of this series belong to the Ptolemaic epoch, and hence pertain to the Greek inhabitants of that age: but it must be remembered that the rule of the Ptolemies lasted but about three hundred years; whereas the Egyptians were themselves the masters of Memphis, and entombed their dead

in its necropolis more than two thousand years before either the Persians or Greeks effected the conquest of the country, no less than during the period of and after these epochs of foreign domination.

Of the sixteen adult Pelasgic skulls in this series, two or three are small; yet the whole number gives about 88 cubic inches for the average internal capacity of the cranium, or size of the brain, while the mean of the facial angle is 80°. The seven Egyptian crania have a mean internal capacity of 80 cubic inches, and a facial angle of 77°.

SECOND SERIES.

FOUR HEADS FROM THE GROTTOES OF MAABDEH, NEAR MAGARAT-ES-SAMÒUN.

This is the name of a series of sepulchral grottoes in Middle Egypt, on the limestone hill opposite Manfaloot, and near the modern village of Maabdeh. It is within the ancient nome of Heracleopolis. This cemetery is a natural cavern, which was chiefly dedicated to embalmed crocodiles, but in some measure, also, to man. Mr. Gliddon observes that the human mummies are of the common order, and adds: "I brought them from a measured distance of 438 feet under ground, horizontally, averaging about twenty feet below the surface."

Plate IV., Fig. 1. (Cat. 833.) A large, oval head, with a very low, receding forehead, and large, aquiline nose. A man of 35 years? The hair is long, soft, and curling, and the beard is partially preserved on the lower jaw. *Pelasgic form?*

This person has been much disfigured by ulceration of the cartilage of the nose and the adjacent integuments; part of the upper lip has been removed by the disease, which appears partially on the lower jaw, and may account for the beard not having been shaved. The embalming process has been very carefully conducted. Large lozenge-shaped patches of gold-leaf are seen on the centre of the forehead and over each eye, with smaller pieces dispersed in other places, and especially on the *bone* and *teeth* of the upper jaw, where these have been denuded or exposed by ulceration.

Plate IV., Fig. 2. (Cat. 834.) A female head, of a short, oval form, with a narrow, receding forehead, prominent nose, and very protruding maxillæ. The teeth, which are salient, indicate a person of 25 or 30 years of age; and the lower jaw, which is very angular, has a remarkable downward projection. The hair was long, but harsh, and was necessarily removed with the integuments, on account of the imperfect nature of the embalment, which appeared to have been effected with a soft or tar-like bitumen. *Negroid form.*

Plate IV., Fig. 3. (Cat. 835.) A woman of 30? with a long, narrow head, slightly salient nose, and very projecting face. The hair is eight or ten inches long, harsh, but not wiry. *Negroid form.* I. C. 71 cubic inches. F. A. 73°.

Plate IV., Fig. 4. (Cat. 836.) A female head of a fine oval form, with a broad, convex forehead, low coronal region, and strongly aquiline nose. This head retains a profusion of long, fine, curling hair, and the face is gilded over the eyes and lips. This is a striking example of the *tumid face* which is not unfrequently seen on the monuments. *Egyptian form.*

Remarks.—The two Negroid heads belong, obviously, to the lower class of people, for the bodies have been hastily and imperfectly embalmed, without mummy cases, and in ordinary wrappings. The two latter remarks apply to the other individuals of this series, which have, nevertheless, been much more carefully embalmed.

THIRD SERIES.

FOUR SKULLS FROM ABYDOS.

The city of Abydos, the second in size in the Thebaid, was on the west bank of the Nile, and, like Thebes, possessed a palace of Rameses III., and a temple of Osiris, the guardian divinity of the city.

Plate V., Fig. 1, (Cat. 819.) An elongated head, with an indifferent frontal and low coronal region, straight nose, small orbits, and prominent upper jaw.—I. C. 85 cubic inches. F. A. 79°. *Egyptian form.*

Plate V., Fig. 2. (Cat. 820.) A large and finely moulded cranium, with a broad, full forehead, and long, but abruptly salient nose. The upper jaw has a remarkable downward elongation, which reduces the F. A. to 76°.—I. C. 96 cubic inches. A man of 40. *Egyptian form.*

Plate V., Fig. 3. (Cat. 817.) A large, beautifully developed cranium, of harmonious proportions, but somewhat ponderous structure.—I. C. 89 cubic inches. F. A. 80°. *Pelasgic form.*

Plate V., Fig. 4. (Cat. 818.) A small head, narrow and retreating, with a tumid occiput, very large, aquiline nose, and delicate, prominent face.—I. C. 69 cubic inches. F. A. 77°. *Semitic form.*

Remarks.—In a memorandum accompanying these skulls, Mr. Gliddon observes that "they were obtained from a mummy-pit behind the temple of Rameses III., and they belong to the best class. Among the relics found in the same pit were a scarabæus, bearing the prenomen of Thotmes IV., and a piece of stamped pottery, (apparently enclosed with a mummy to denote the epoch,) which bore the nomen of Rameses III. It may, therefore, be reasonably conjectured, that these remains belong to the eighteenth Diospolitan dynasty, fixed by Professor Rosellini between the years 1822 and 1874, B. C."

The four heads are entirely denuded, but little appearance of bitumen remaining; nor is the ethmoid bone perforated. The bones bear the impress of age, and, in one instance, have become softened, and almost friable, from decomposition.

FOURTH SERIES.

FIFTY-FIVE HEADS FROM THE CATACOMBS OF THEBES.

The greater part of this extensive and singularly perfect and varied series of heads, was collected by Mr. Gliddon during two visits to Thebes. They were all taken from

the catacombs at *El Gourna*, on the western bank of the Nile. If we may judge by the different degrees of care manifested in the embalming process, they embrace individuals of every class excepting the highest and lowest; for the latter, according to the testimony of Herodotus, were never embalmed in the proper sense of that word; and the former were deposited in more elaborate sepulchres.

Plate VI., Fig. 1. (Cat. 860.) A man of fifty, with a small but well proportioned cranium. The bones of the face are small, and the whole osseous structure very thin. —I. C. 80 cubic inches. F. A. 82°. *Egyptian form.*

(Cat. 853.) Head of a man of fifty, with a low coronal region, receding forehead, full occiput, aquiline nose, and remarkable flatness beneath the temporal muscles.—I. C. 95 cubic inches. *Egyptian form.*

Plate VI., Fig 2. (Cat. 865.) An oval head with a full but retreating forehead, a large, aquiline nose, and angular, prominent face. The eyes are embalmed open. *Semitic form.*

Plate VI., Fig. 3. (Cat. 893.) A singularly thin cranium, especially in the lateral parietal regions. The forehead is moderately expanded and the nose straight.—I. C. 85 cubic inches. F. A. 81°. *Pelasgic form.*

Plate VI., Fig. 4. (Cat. 850.) A large oval cranium, with a voluminous forehead, a small aquiline nose, and rounded orbits. Age, seventy to eighty years?—I. C. 86 cubic inches. *Pelasgic form.*

Plate VI., Fig. 5. (Cat. 859.) An octogenarian female, with a small but well proportioned head, and delicate facial bones. This cranium, which is remarkable for its tenuity, retains a very little smooth, long hair.—I. C. 82 cubic inches. *Pelasgic form.*

Plate VI., Fig. 6. (Cat. 881.) Skull of a female not exceeding seventeen years of age, with a beautifully developed forehead, and delicate facial bones, yet possessing an obvious downward elongation of the upper jaw, as in the Hindoo.—I. C. 71 cubic inches. F. A. 80°. *Egyptian form.*

Plate VI., Fig. 7. (Cat. 889.) A well formed, oval head, with a remarkably prominent nose and chin.—I. C. 83 cubic inches. F. A. 83°. *Egyptian form.*

Plate VI., Fig. 8. (Cat. 870.) A long oval cranium, with a broad, receding forehead, tumid occiput, very long aquiline nose, and sharp features. The hair, which is cut close, is brown and silky.—I. C. 79 cubic inches. A man of thirty? *Semitic form.*

Plate VI., Fig. 9. (Cat. 876.) A small, but oval male head, with hair of a fine texture and brown colour.—I. C. 83 cubic inches. *Egyptian form.*

Plate VII., Fig. 1. (Cat. 851.) A narrow, elongated cranium, with a retreating forehead, and rather produced maxillæ. The whole osseous structure is remarkably delicate. A woman of thirty-five?—I. C. 79 cubic inches. F. A. 80°. *Egyptian form.*

Plate VII., Fig. 2. (Cat. 861.) Skull of a man of fifty, large and massive: forehead and coronal region but moderately developed; face projecting, with a small, aquiline nose.—I. C. 91 cubic inches. F. A. 78°. *Egyptian form.*

Plate VII., Fig. 3. (Cat. 857.) A female cranium, long, narrow, and much flattened at the sides, and rather ponderous. The whole face is long, angular, and prominent, with a slight yet manifest negro expression. A little hair remains, long, black, and smooth.—I. C. 83 cubic inches. F. A. 77°. *Egyptian, blended with the Negro form?*

Plate VII., Fig. 4. (Cat. 848.) A female head, with a narrow but elevated and finely arched frontal region, which forms, with the straight nose, something of a Grecian profile. The face, however, is not in keeping with the head, being much produced.—I. C. 82 cubic inches. F. A. 80°. *Egyptian form.*

Plate VII., Fig. 5. (Cat. 847.) A small head, narrow and laterally compressed, with a well formed forehead, and full occiput. The nose is very large and salient, and the maxillary structure much produced. A woman of thirty.—I. C. 68 cubic inches. F. A. 76°. *Egyptian form.*

Plate VII., Fig. 6. (Cat. 854.) A small but well proportioned cranium of a female not exceeding fifteen years of age. The forehead is full (by an oversight inadequately represented in the drawing,) and the whole of the osseous structure extremely delicate. *Egyptian form.*

(Cat. 849.) Skull of a man of twenty-five years, finely oval, with a broad receding forehead, and full coronal region. Facial bones broken.—I. C. 81 cubic inches. *Egyptian form.*

(Cat. 894.) A beautiful juvenile head, with a broad high forehead, large, prominent nose, and oval orbits. *Pelasgic form.*

(Cat. 887.) A child of twelve or fourteen years, with a finely turned forehead, long, aquiline nose, and vertical teeth. A little long, fine hair remains on the occiput. *Egyptian form.*

(Cat. 868.) Skull of a child of beautiful organization, excepting a slight inequality in the occipital region. *Pelasgic form.*

Plate VIII., Fig. 1. (Cat. 878.) An elongated head, with a broad receding forehead, long and nearly straight nose, and prominent chin. This person has been most carefully embalmed, with a profusion of gilding on various parts of the face. The hair is soft and curling, and of a dark-brown colour. A man of fifty?—I. C. 77 cubic inches. *Egyptian form.*

Plate VIII., Fig. 2. (Cat. 879.) A man of fifty, admirably embalmed. A broad and full, but receding forehead, a large aquiline nose, and strong maxillæ. *Pelasgic head* of the Roman conformation.

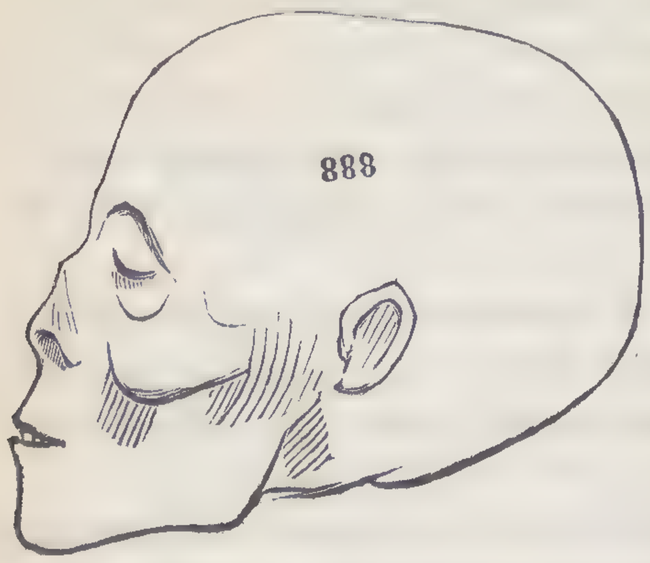
Plate VIII., Fig. 3. (Cat. 839.) A short-oval cranium, with a full but retreating forehead, straight nose, and large prominent maxillæ.—I. C. 74 cubic inches. F. A. 78°. *Egyptian blended with the Negro form?*

Plate VIII., Fig. 4. (Cat. 871.) A juvenile female head, with a full but receding frontal region, long nose, sharp features, tumid occiput, and rounded orbits. *Egyptian form.*

Plate VIII., Fig. 5. (Cat. 866.) A small, juvenile, female head, with a convex but retreating forehead, and the whole face remarkably sharp, projecting, and repulsive. This head is elaborately gilded, and retains a portion of long, fine, smooth hair. *Egyptian form?*

(Cat. 873.) An oval cranium, with a good frontal region, and salient nasal bones. The alveoli have been almost destroyed by absorption consequent to advanced age.—I. C. 88 cubic inches. *Pelasgic form?*

Plate VIII., Fig. 6. (Cat. 883.) A well developed cranium, with a long straight nose. A man of forty?—I. C. 82 cubic inches. F. A. 81°. *Egyptian form.*



(Cat. 888.) Head of a man of thirty-five years? most carefully embalmed, with a high frontal region, and very long prominent angular face.—I. C. 85 cubic inches. *Egyptian* blended with Negro or Malay lineaments? The conformation of this head is not unlike that of some modern Nubians.

Plate VIII., Fig. 7. (Cat. 880.) A female head? of a fine oval form, long, straight nose, and quadrangular orbits. The angles of the lower jaw are remarkably expanded. The hair, which is cut short, is fine, and of a dark-brown colour.—I. C. 85 cubic inches. F. A. 80°. *Egyptian form.*

Plate VIII., Fig. 8. (Cat. 867.) A large head with a broad convex frontal region, and full occiput. The nose is large and remarkably salient, and the maxillary bones projecting and ponderous. A little soft, dark-brown hair is attached to some remaining fragments of the scalp.—I. C. 86 cubic inches. F. A. 78°. *Egyptian form.*

This person has evidently undergone decapitation, and in order to attach the head again to the body, a ball of mummy cloth has been formed on the end of a piece of reed *within the cranium*, and the other end has been thrust between the spine and adjacent muscles, and confined there by bandages. There is also an excision of the occipital protuberance, by means of an axe or other sharp instrument, seemingly made by an unskilful effort to sever the head from the body.

Plate VIII., Fig. 9. (Cat. 855.) Head of a female not exceeding eighteen years of age, with a finely developed forehead, very long aquiline nose, small but prominent face, and very peculiar features. Hair, dark-brown, and extremely fine. The face is gilded. —I. C. 78 cubic inches. *Egyptian form.*

(Cat. 874.) Head of a child of nine or ten years, closely shaved and elaborately gilded, with a high, full forehead, projecting jaws, and oblique teeth. *Egyptian blended with the Negro form?*

(Cat. 48.) Skull of a child of eight years, with a fine frontal region, but rather prominent face. Hair long, and of a dark brown colour. *Egyptian form.*

Plate IX. (Cat. 856.) A cranium of harmonious proportions, with a fine forehead, gently aquiline nose, delicate facial bones, and perfect teeth. A man of thirty?—I. C. 92 cubic inches. F. A. 80°. *Egypto-Pelasgic form.*

Plate X., Fig. 1. (Cat. 844.) A finely formed female head, with a straight nose, and delicate facial bones. Hair abundant, soft, and curling.—I. C. 68 cubic inches. *Egyptian form.*

Plate X., Fig. 2. (Cat. 872.) A woman of fifty?—with a low receding forehead, and prominent facial structure. Hair abundant, long, and very fine, of a light brown or auburn colour, and elaborately curled and platted.—I. C. 72 cubic inches. *Egyptian form.*

Plate X., Fig. 3. (Cat. 862.) Head of a man of sixty, with a broad receding forehead,

salient nose and light facial bones. Hair, long, soft, and curling.—I. C. 79 cubic inches. *Egyptian form.*

Plate X., Fig. 4. (Cat. 843.) Head of a woman of thirty? most carefully embalmed; with a full forehead, very long, straight nose, and sharp delicate features, but prominent face. There is a profusion of long, brown, curling hair.—I. C. 74 cubic inches. *Egyptian form.*

Plate X., Fig. 5. (Cat. 877.) Head of a man with a broad receding forehead, salient nose, and delicate features. Hair, dark-brown, smooth and curling. The beard, though short, is preserved.—I. C. 89 cubic inches. *Egyptian form.*

Plate X., Fig. 6. (Cat. 60.) Head of a female not exceeding eighteen years of age, with a low forehead, long, straight nose, and rather prominent face. Hair long and fine. This style of head is very common on the Egyptian monuments. *Egyptian form.*

Plate X., Fig. 7. (Cat. 882.) Head of a young girl, with a very prominent nose, and long, smooth, curling hair: gilding on the eyelids and nose. *Egyptian form.*

Plate X., Fig. 8. (Cat. 884.) Head of a woman of thirty, of a faultless Caucasian mould. The hair, which is in profusion, is of a dark-brown tint, and delicately curled. *Pelasgic form.*

Plate X., Fig. 9. (Cat. 875.) A small female head, of seventy? years, with a fine frontal development, straight nose, and large oval orbits. The long, curling hair is of a yellowish colour, but has probably been gray, and dyed by *henna*.—I. C. 73 cubic inches. *Egyptian form.*

Plate XI., Fig. 1. (Cat. 846.) Head of a youth of about eighteen years, with a remarkably broad and lofty forehead, a small straight nose, and delicately formed face. A little smooth, dark hair remains, and the whole has been elaborately embalmed, with a profusion of gilding on the face.—I. C. 87 cubic inches. This is one of the most perfectly formed heads that have ever come under my notice, yet the eyes are widely separated, the distance between the nose and mouth is remarkable, and the chin is short and receding. *Egypto-Pelasgic form.*

Plate XI., Fig. 2. (Cat. 842.) Head of a man of about fifty years of age, with a broad but very low and receding forehead. The nose is very large, and strongly aquiline, the teeth vertical and much worn, the cheek bones prominent, and the whole face remarkable for harshness of expression. A little brown hair remains on the occiput.—I. C. 85 cubic inches. *Semitic form.*

This head possesses great interest, on account of its decided Hebrew features, of which many examples are extant upon the *monuments*.

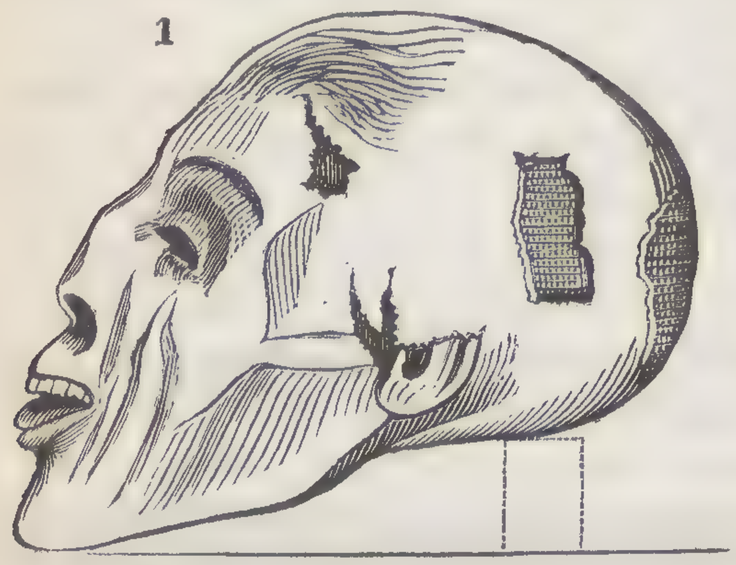
(Cat. 886.) Head of a man of fifty? small but well proportioned throughout. The teeth, which are vertical, are remarkably worn by attrition.—I. C. 76 cubic inches. *Egyptian form.*

Plate XII., Figs. 1, 2. (Cat. 845.) An oval head with a full forehead, and long aquiline nose. The orbits are far apart, and the balls replaced with bone, on which the iris is distinctly painted. The hair, which is cut short, is fine and straight.—I. C. 73 cubic inches. This head has something of the *Semitic* character, both as respects configuration and expression, and I class it, though with some hesitation, with that series.

TWO HEADS OF LUNATICS, FROM THEBES.

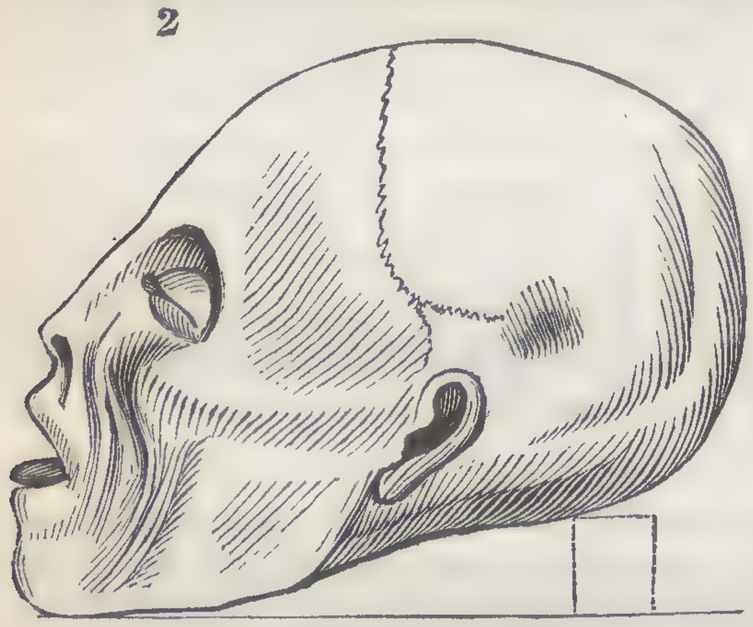
Wood-cut 1. (Cat. 841.) An elongated head, with a very receding forehead, long, aquiline nose, and large, ponderous jaws, which project so as to reduce the facial angle to about 65°. This person has been embalmed with evident care, but with the mouth open, the tongue protruded, and the eyelids raised, giving a frightfully vacant expression to the whole countenance, and leaving no reasonable doubt that this is the head of an idiot. A little hair remains, which is remarkably fine, and encroaches on the eyebrows.

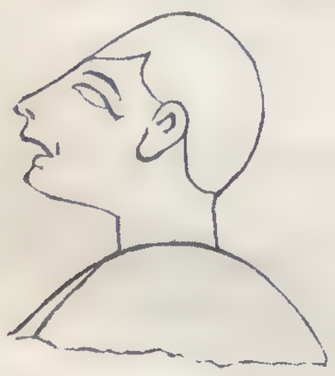
1



Wood-cut 2. (Cat. 863.) Another idiotic head, embalmed also with the mouth open and the tongue partially protruded. The cranium is long, the forehead low and receding, the face remarkably prominent, and the whole expression, as in the former instance, to the last degree vacant and repulsive. I presume that no one accustomed to comparisons of this nature can examine these heads, without agreeing with me in opinion as to their position in the intellectual scale. It may appear, and, indeed, is surprising, that two idiotic heads should be found among one hundred taken at random from the catacombs; and I can only explain the fact by supposing that a particular tomb was reserved for this unfortunate class of persons; and that the Arab servant employed by Mr. Gliddon, in his explorations at Thebes, invaded by chance this very sanctum. It is well known that idiotic persons have, in all ages, been regarded with a certain degree of veneration in the East; and hence their remains would be likely, in Egypt, to be carefully preserved after death. In examining Professor Rosellini's plates, I find a solitary example of an idiot, whose head is represented in the annexed diagram; and it is curious to remark, that the sagacity of the Egyptian artist has admirably adapted this man's vocation to his intellectual developments, for he is employed in stirring the fire of a blacksmith's shop. This singular effigy is seen at Thebes.

2





NEGROID HEADS.

In addition to the two heads of this class from Maabdeh and one from Memphis, I subjoin descriptions and outline drawings of five others from Thebes, which are here grouped for the advantage of more ready comparison.

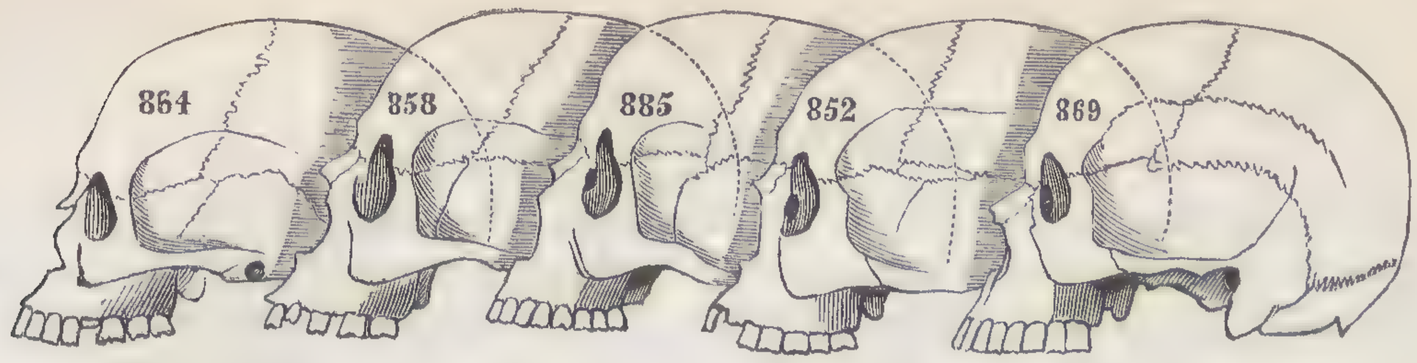


Fig. 1. (Cat. 864.) A female cranium, of a narrow oval form, with a low, receding forehead, small nose, and protruding face. There is much of the Negro *expression* in the bony structure of this head.—I. C .77 cubic inches. F. A. 75°.

Fig. 2. (Cat. 858.) A large and rather ponderous cranium, with a well developed forehead, salient nose, jaws powerfully developed and protruding, and the upper teeth presenting obliquely outwards.—I. C. 87 cubic inches. F. A. 77°.

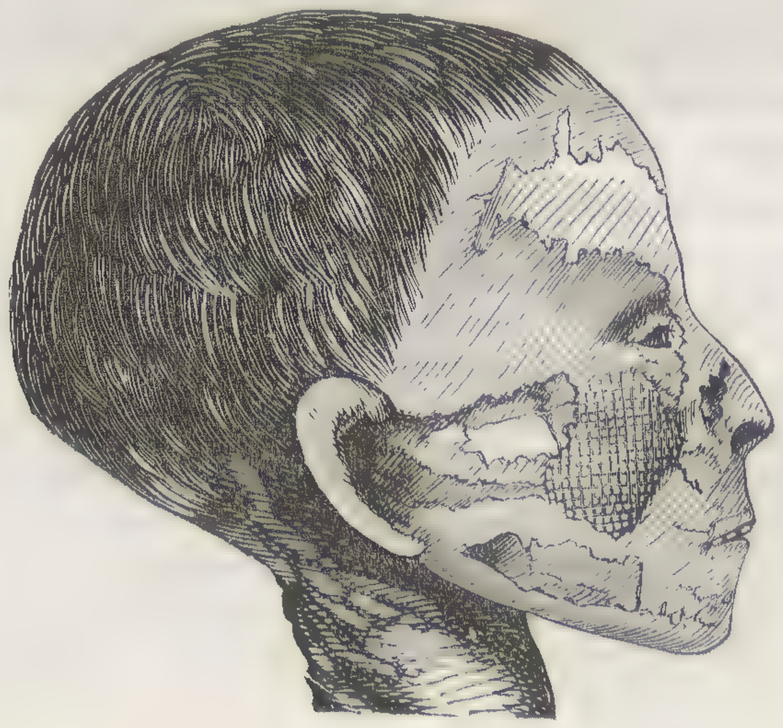
Fig. 3. (Cat. 885.) An oval head, with a convex frontal region, small, depressed nose, and very projecting face.—I. C. 77 cubic inches. F. A. 76°.

Fig. 4. (Cat. 852.) A small head, with a low, receding forehead, and strong, small nose, projecting maxillæ, and obvious Negro expression. A little hair remained, which was cut short, and was coarse without being woolly.—I. C. 77 cubic inches. F. A. 75°.

Fig. 5. (Cat. 869.) An oval head, with a good frontal development, salient nose, and very projecting face.—I. C. 88 cubic inches. F. A. 76°.

In the preceding five crania, the Negro features and expression greatly predominate; at the same time there is an evident mixture of Caucasian characters. Two of them might pass, perhaps, for genuine Negroes, but for the comparatively fine texture of the hair. I therefore regard them as Mulattoes, to which class, also, may be referred a large proportion of the modern Copts.

(Cat. No. 1044.) The subjoined wood-cut illustrates a remarkable head, which may serve as a *type* of the genuine Egyptian conformation. The long, oval cranium, the receding forehead, gently aquiline nose, and retracted chin, together with a marked distance between the nose and mouth, and the long, smooth hair, are all characteristic of the monumental Egyptian.



FIFTH SERIES.

THREE HEADS FROM KOUM OMBOS.

The remains of this once celebrated city are seen on a sandy hill on the eastern bank of the Nile, to the south of Thebes. The Ombites were celebrated for the worship of the crocodile, which they embalmed with care and deposited in the catacombs. The three following heads were obtained by Mr. Gliddon from the Ombite necropolis.

Plate XII., Fig. 3. (Cat. 830.) A female head of 30 years, with a low, narrow forehead, straight nose, and sharp, prominent features. The hair, which is in profusion, is long, fine and curling.—I. C. 77 cubic inches. *Egyptian form.*

Plate XII., Fig. 4. (Cat. 831.) Head of a woman of 30 years?, with a narrow, but high and convex forehead, strong aquiline nose, and sharp facial structure. The hair is abundant, long, fine and curling.—I. C. 68 cubic inches. *Egyptian form.*

Plate XII., Fig. 5. (Cat. 832.) An oval, thin skull, with a good frontal development, salient nose and delicate facial bones.—F. A. 81°. *Egyptian form.*

It is remarkable that two of the preceding skulls (the third being too much broken for measurement) give an average internal capacity of less than 73 cubic inches.

SIXTH SERIES.

FOUR HEADS FROM A TUMULUS NEAR THE ISLAND OF PHILÆ.

Philæ was the ancient boundary between Egypt and Nubia, and this little island contained several of the most venerated shrines of the Egyptian deities. The island of Beggeh (the ancient Senem) was also a consecrated spot, and is immediately contiguous to Philæ. It contains a funereal tumulus, which is supposed to have been the common sepulchre of those pilgrims who died during their sojourn, and hence, as Mr. Gliddon remarks in his memoranda, "they may have been of any nation or of any epoch."

Plate XII., Fig. 6. (Cat. 821.) A finely moulded head, with a good frontal development, aquiline nose, and delicate facial bones.—I. C. 74 cubic inches. F. A. 79°. *Pelasgic form.*

(Cat. 822.) A juvenile head, of perhaps 12 years, thin and inequilateral, with a good forehead, and broad, inter-parietal diameter. The face is broken, and the ethmoid bone imperforate. *Egyptian form.*

(Cat. 824.) A very narrow, infantile head, with brown, soft, curling hair. The face is deficient, and the head is rather desiccated than embalmed. *Egyptian form?*

Plate XII., Fig. 7. (Cat. 823.) An unmixed *Negro*, with a narrow, elongated head, well-developed forehead, short and flat nasal bones, everted upper jaw, and short, gray, woolly hair. This appears to be the cranium of a woman of at least 60 years of age. The bones are thin, and the whole structure remarkably small.—I. C. 73 cubic inches.

SEVENTH SERIES.

FOUR SKULLS FROM DEBÔD, IN NUBIA.

Debôd or Deboud is about twelve miles south of Philæ, on the left bank of the Nile, and in north latitude 24°. It was the site of the ancient Parembole, and yet possesses some ruins of a once splendid temple of Ammon.

The following heads were all obtained from a single pit, and from the rude manner in which they were embalmed and wrapped, Mr. Gliddon (who obtained them with his own hands) supposes them to have pertained to people of the lower order.

Plate XII., Fig. 8. (Cat. 829.) Skull of a woman of 50? with a low but convex forehead, with which the nasal bones have formed a nearly straight line. The coronal region is low, and the whole osseous structure strong and rather harsh.—*Egyptian form.* I. C. 70 cubic inches. F. A. 85°.

Plate XII., Fig. 9. (Cat. 827.) Skull of a man of 40, which strongly resembles the preceding. The forehead is low, but broad and vertical, the whole cranium long, the coronal region compressed, the orbits large, and the upper maxillæ slightly everted.—I. C. 82 cubic inches. *Egyptian form.*

Plate XIII. (Cat. 826.) A fine oval head, with a broad, high, convex forehead, large, straight nose, and rather prominent maxillæ. On one side is a mass of long, black hair, much curled, and of a fine texture.—I. C. 74 cubic inches. F. A. 77°. *Egyptian form.*

(Cat. 828.) An elongated, infantile head, with a narrow but vertical forehead, delicately formed face, very full occiput, and (what is not uncommon in children) a F. A. of 90°. *Egyptian form.*

Remarks.—In addition to the preceding details, it remains to offer some general observations on the size and configuration of the head, together with a tabular view of the whole series of crania, arranged in the first place, according to their sepulchral localities, and, in the second, in reference to their national affinities.

*Ethnographic Table of one hundred ancient Egyptian Crania.**

Sepulchral Localities.	No.	Egyptian.	Pelasgic.	Semitic.	Mixed.	Negroid.	Negro.	Idiot.
Memphis,	26	7	16	1	1	1		
Maabdeh,	4	1	1			2		
Abydos,	4	2	1	1				
Thebes,	55	30	10	4	4	5		2
Ombos,	3	3						
Philæ,	4	2	1				1	
Debôd,	4	4						
	100	49	29	6	5	8	1	2

* It will be observed, on comparing this table with the original one published in the *Proceedings* of the Society for December, 1842, (and since republished in Mr. Gliddon's *Ancient Egypt*,) that there is a great difference in the relative number of Pelasgic and Egyptian heads; which fact has been already adverted to, and explained, (page 96.) I have been governed in the present classification, by the manifest presence of the Egyptian physiognomy, even in those instances in which it appears to be blended with an equal and even preponderating Pelasgic character. It will be observed, however, that *the whole number of Caucasian heads* is nearly the same in both tables; and that the relative proportion of Semitic, Negro and Negroid crania is unaltered.

The preceding table speaks for itself. It shows that more than eight tenths of the crania pertain to the unmixed Caucasian race; that the Pelasgic form is as one to one and a half, and the Semitic form one to eight, compared with the Egyptian: that one twentieth of the whole is composed of heads in which there exists a trace of Negro and other exotic lineage:—that the Negroid conformation exists in eight instances, thus constituting about one thirteenth part of the whole; and, finally, that the series contains a single unmixed Negro.

To these facts I shall briefly add the results of the observations of some authors who have preceded me in this inquiry. "I have examined in Paris, and in the various collections of Europe," says Cuvier, "more than fifty heads of mummies, and not one amongst them presented the characters of the Negro or Hottentot."*

Two of the three mummy heads figured by Blumenbach, (Decad. Cran., Figs. 1 and 31,) are unequivocally Egyptian, but the second, as that accurate observer remarks, has something of the Negro expression.† The third cranium delineated in the same work, (Plate 52,) is also Caucasian, but less evidently Egyptian, and partakes, in Professor Blumenbach's opinion, of the Hindoo form. Of the four mummies described by Söemmering, "two differed in no respect from the European formation; the third had the African character of a long space marked out for the temporal muscle; the characters of the fourth are not particularized. The skulls of four mummies in the possession of Dr. Leach, of the British museum, and casts of three others, agree with those just mentioned in exhibiting a formation not differing from the European, without any trait of the Negro character."‡

The two heads figured in the great French work, are both decidedly Egyptian, but the second and smaller one is the most strongly marked.§

Internal Capacity of the Cranium.‖—As this measurement gives the size of the brain, I have obtained it in all the crania above sixteen years of age, unless prevented by fractures or the presence of bitumen within the skull; and this investigation has confirmed the proverbial fact of the general smallness of the Egyptian head, at least as observed in the catacombs south of Memphis. Thus, the Pelasgic crania from the latter city, give an average internal capacity of eighty-nine cubic inches; those of the same group from Thebes give eighty-six. This result is somewhat below the average of the existing Caucasian nations of the Pelasgic, Germanic, and Celtic families, in which I find the brain to be about ninety-three cubic inches in bulk. It is also interesting to observe that the Pelasgic brain is much larger than the Egyptian, which last gives an average of but eighty cubic inches; thus, as we shall hereafter see, approximating to that of the Indo-Arabian nations.

* Lawrence's Lectures on Zoology, &c., p. 347.

† Decas Quarta, p. 6.

‡ Lawrence, ut supra, eighth edition, p. 325.

§ Description de L'Egypte, Antiq. II., pl. 49, 50.

‖ In my Crania Americana, p. 283, I have described an ingenious method of measuring the internal capacity of the cranium, devised by my friend Mr. John S. Phillips. The material used for filling the skull, as there directed, was white pepper seed, which was chosen on acount of its spheroidal form, and general uniformity of size. Finding, however, that considerable variation occurred in successive measurements of the skull, I substituted leaden shot one tenth of an inch in diameter, in place of the seeds. The skull must be *completely filled* by shaking it while the shot is poured in at the foramen magnum, into which the finger must be frequently pressed for the same purpose, until the various sinuosities will receive no more. When this is accomplished, the shot on being transferred to the tube, will give the *absolute* capacity of the cranium, or *size of the brain*, in cubic inches.

The largest head in the series measures ninety-seven cubic inches; this occurs three times, and always in the Pelasgic group. The smallest cranium gives but sixty-eight cubic inches, and this is three times repeated in the Egyptian heads from Thebes. This last is the smallest brain I have met with in any nation, with three exceptions,—a Hindoo, a Peruvian, and a Negro.

The Negroid heads, it will be observed, measure, on an average, eighty cubic inches, which is below the Negro mean; while the solitary Negro head (that of a person advanced in years,) measures but seventy-three cubic inches.*

As this, however, is a question of much interest and some novelty, it may, perhaps, be better illustrated in a tabular form:—

Ethnographic Division.	Locality.	No. of Crania.	Largest Brain.	Smallest Brain.	Mean.	
Pelasgic Form.	Memphis.	14	97	79	89	Mean, 88 C. I.
	Abydos.	1	89	89	89	
	Thebes.	5	92	82	86	
	Philæ.	1	74	74	74	
Semitic Form.	Memphis.	1	88	88	88	Mean, 82.
	Abydos.	1	69	69	69	
	Thebes.	3	85	79	79	
Egyptian Form.	Memphis.	7	83	73	79	Mean, 80.
	Abydos.	2	96	85	90	
	Thebes.	25	95	68	80	
	Ombos.	2	77	68	73	
	Debôd.	3	82	70	75	
Negroid Form.	Maabdeh.	1	71	71	71	Mean, 79.
	Thebes.	5	88	71	81	
Negro.	Philæ.	1	73	73	73	Mean, 73.

* I have in my possession seventy-nine crania of Negroes born in Africa, for which I am indebted to Doctors Goheen and M'Dowell, lately attached to the medical department of the Colony at Liberia, in western Africa; and especially to Don Jose Rodriguez Cisneros, M. D., of Havana, in the island of Cuba. Of the whole number, fifty-eight are adult, or sixteen years of age, and upwards, and give eighty-five cubic inches for the average size of the brain. The largest head measures ninety-nine cubic inches; the smallest but sixty-five. The latter, which is that of a middle-aged woman, is the smallest adult head that has hitherto come under my notice.

Facial Angle.—I have carefully measured the facial angle in all those *adult* skulls which are sufficiently denuded for that purpose, and have obtained the following results:—

Ethnographic Division.	No. Measured.	Largest.	Smallest.	Mean.
Pelasgic form,	16	83°	73°	80°
Egyptian form,	20	83°	76°	78°
Semitic form,	2	77°	74°	75°
Negroid form,	6	77°	73°	75°

It is stated by M. Virey, that the numerous mummies which have been brought to Europe present the full facial angle of the Caucasian race.

The Structure of the Cranial Bones is as thin and delicate as in the European, and a ponderous skull is of unfrequent occurrence. I make this remark with the more satisfaction because it enables me to contest one of the observations of Herodotus; who tells us, that on visiting the field of battle whereon the Egyptians had fought with the Persians, he saw the bones of the latter lying on one side, and those of their enemies on the other. He then adds, that "the skulls of the former were so extremely soft as to yield to the slightest impression, even of a pebble; those of the Egyptians, on the contrary, were so firm that the blow of a large stone would hardly break them." The historian then explains the reason of this difference, by stating that the Egyptians have thicker skulls, because their heads are frequently shaved and more exposed to the weather: while the Persians have soft skulls, owing to the habitual use of caps which protect their heads from the sun.

These reveries are wholly untenable in a physiological point of view, and derive not the smallest support from anatomy itself; nor can there be a question that the confiding historian received his impressions through the ignorance or imposition of others. I have in my possession eight skulls of Fellahs, or modern Egyptian peasants, who habitually shave the head, and wear a thin cap; and yet their skulls, which are of various ages from early youth to senility, are without exception thin and delicate.

Some modern authors have also attributed to the mummy skulls a *density* which is not characteristic, but which is adventitiously acquired by the infiltration of bitumen into the diplöic structure during the process of embalming.

Hair.—The hair is fortunately preserved on thirty-six heads, in some instances in profusion, in others scantily, but always in sufficient quantity to enable us to judge of its texture. Thirty-one of these examples pertain to the Caucasian series, and in these the hair is as fine as that of the fairest European nations of the present day. The embalming process has changed it, with a few exceptions, from a black to a dark-brown colour. There are also several instances of gray hair, and two in which it is of a true flaxen colour: it is more than probable, however, that the latter hue has been produced artificially,—a practice still in use among the Saumaulies south of Adel.

The preceding remarks on the texture of the hair accord with those of other observers,

as well as with the monumental evidences of every epoch. Belzoni obtained platted hair from the Theban catacombs eighteen inches in length; and M. Villoteau mentions another instance, from the same tombs, in which the tresses must have reached to the waist. Entire wigs of the same character are preserved, as every one knows, in the British and Berlin museums; and I also possess, through the kindness of Mr. Gliddon, a portion of a similar relic from Thebes, which is elaborately wrought into a great number of long and most delicate tresses.

These facts lead to a few observations on the celebrated passage of Herodotus, who, when speaking of the Colchians, gives, among other proofs of their Egyptian lineage, that they "were black, and had short curling hair." *Μελαγχροες και ουλοτριχες.* The above translation, which is that of the learned Beloe, expresses, in respect to the mode of *wearing* the hair, precisely what is verified by my observations; for in nearly all the Caucasian heads on which it has been allowed to grow, it is remarkable for a profusion of short curls of extreme fineness,—a character which is preserved in several of the accompanying delineations.

Herodotus farther tells us that the Egyptians kept their heads shaved; or perhaps he might have said with more precision, closely cut. But while the priests conformed to this rule, we are certain, from the foregoing facts, that there was a diversity of usage among the other classes, which is also proved by another passage in the same historian; for he assures us that "you see fewer bald in Egypt than in any other country." Now if the Egyptians of all classes kept their heads shaved, it would be difficult to ascertain, and yet more difficult to *see* whether they were subject to natural baldness or not. Again, if Herodotus had not been accustomed to observe the Egyptians *wearing* their hair, how could he have compared them in this respect to the people of Colchis?

The same author informs us that the inhabitants of Egypt permitted their hair to grow as a badge of mourning; an observation which is every where corroborated in monumental funereal scenes. This observation, however, was probably for a comparatively short period, and will not account for the frequent occurrence of long hair among the mummies of all classes. It is mentioned in history that among other indignities which Cambyses offered to the embalmed body of King Amasis, was that of tearing the hair from his head.

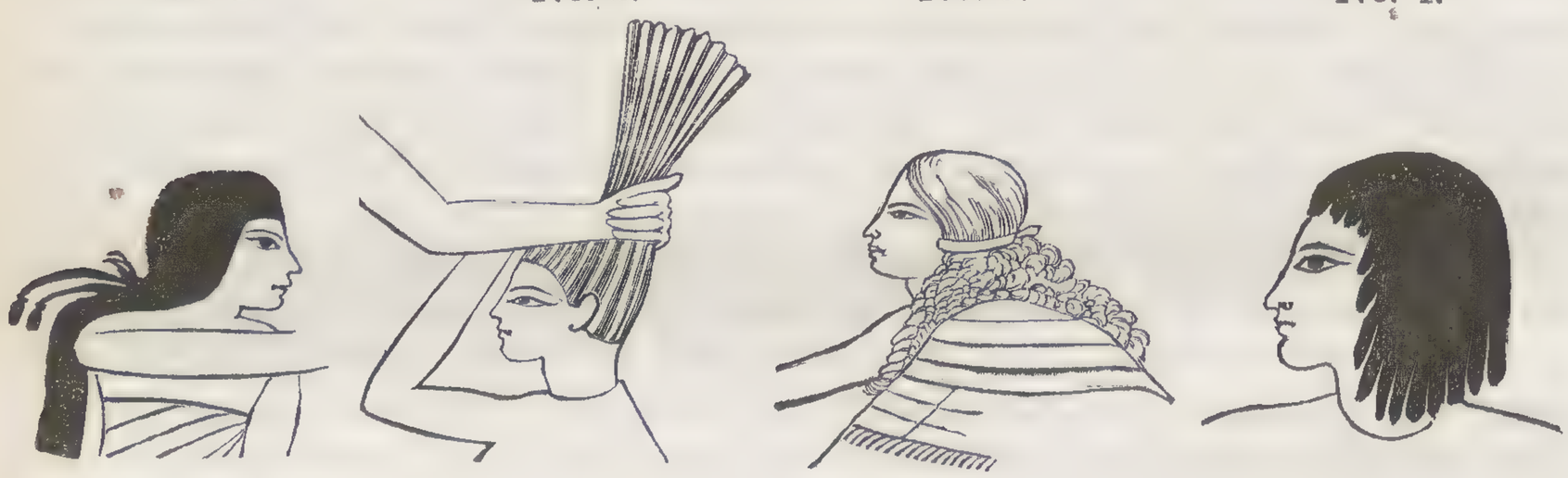
The monuments afford abundant proof that among the Egyptians, from the highest to the lowest castes, it was not unusual to wear the hair long. The marginal drawing represents a rustic, (one of six on the monument,) who is engaged in a wrestling match. And it is hardly to be supposed that the profusion of hair with which his head is covered, can be any other than the natural growth.* A man thus occupied would find a difficulty in keeping a wig on his head.

So also with another from a tomb at Thebes, wherein a carpenter of pleasing but rather effeminate physiognomy, is engaged in the labours of his art.†

* Rosellini, M. R. Plate 102, Fig. 47.
† Idem, M. C. Plate 43, Fig. 45.

Another example, that subjoined (No. 1,) is derived from a funereal procession at Thebes;* but granting, what is quite possible, that the woman in this instance, wears only a head-dress, the contrary can be insisted on in reference to another painting, of a group of five women engaged in athletic exercises, in the midst of which, one of them holds and partially sustains the other by her long, straight hair; showing that the latter could be no other than the natural growth. (No. 2.) It is also interesting to remark, that this picture dates back into "the night of time,"—that remote period antecedent to the eighteenth dynasty, of which this is one of the many remains yet preserved in the celebrated tomb of Novotpth, at Beni Hassan.†

No. 1. No. 2. No. 3. No. 4.



Again, among the funereal processions at Thebes are several boat scenes, from one of which I derive the above drawing, representing an Egyptian woman in the act of lamentation, while her hair falls in long and graceful ringlets below her shoulders. (No. 3.)

Another effigy, (No. 4,) that of an Egyptian lady from a painting in the Theban catacombs,‡ has the hair dressed in the same manner in which it is worn by the modern Nubian girls, as represented in one of the beautiful sketches by Mr. Wathen in his work on Egyptian architecture.

These instances have been selected out of hundreds of a similar character which every where meet the eye on the Nilotic monuments, and which present a most satisfactory accordance with the evidence derived from the catacombs.

Hamilton, in his Ægyptiaca, when describing the paintings at Elytheias, says that "the labourers are dressed in a kind of skull-cap, and have very little if any hair on their heads; while that of the others who superintend them spreads out at the sides, as with the Nubians and Berábera above the cataracts,"—and yet among these very labourers the hair of some is represented so long, that it projects beneath the cap and falls upon the shoulders.§ If I may judge from the heads that have come under my notice, I should infer that the women, as a general rule at least, allowed their hair to grow; but that the practice was much less frequent among the men.

In the heads of every Caucasian type in the series now before us, the hair is perfectly distinct from the woolly texture of the Negro, the frizzled curls of the Mulatto, or the lank, straight locks of the Mongolian.

Of the eight Negroid heads, four are more or less furnished with hair, one is closely

* Rosellini, M. C., Plate 128, Fig. 2. † Idem, Plate 101, Fig. 2. ‡ Rosellini, M. C. Plate 127.
§ Description de L'Egypte, Antiq. T. I. pl. 68. fig. 114.—Hamilton, Ægyptiaca, p. 55.

shaved, and two are entirely denuded. In those which retain the hair, it is comparatively coarse, and in one instance somewhat wiry. The hair of the solitary Negro head possesses the characteristic texture.

I find a short beard (perhaps half an inch in length,) on three Theban heads of the Caucasian part of the series. (Plate IV., Fig. 1, Plate VIII., Fig. 1, and Plate X., Fig. 5.) The Egyptians habitually shaved the beard; but on their statues and paintings we frequently see a *beard-case* which, as Rosellini remarks, appears to be merely emblematical of the male sex and of manhood.

The Teeth.—Professor Blumenbach, in his Decades Craniorum, long ago pointed out what he considered a peculiarity in the conformation of the teeth in some Egyptian mummies; namely, that the crowns of the incisors are very large, thick, and cylindrical, or obtusely conical, in place of having the characteristic chisel-like form.* I have given especial attention to this supposed peculiarity; but although the incisors remain more or less perfect in forty-five crania, embracing upwards of two hundred teeth of this class, I have not been able to confirm the preceding observation. On the contrary, there does not appear to be the smallest deviation from the ordinary form or structure; and I feel confident, that the learned and accurate Blumenbach was deceived by the worn condition of the crowns of the teeth, obviously resulting from the habitual mastication of hard substances. Mr. Lawrence expresses the same opinion, from personal observation: Dr. Prichard inclines to a similar view of the case, and remarks, that "the most satisfactory method of obtaining information is by inspecting the mummies of children." Here, again, I have been so fortunate as to examine the crania of three children from one year old to five years, and five others between the ages of five and ten years. The result is entirely confirmatory of the opinion I have already advanced, and also coincides with the observations of Mr. Estlin.†

What the masticated substances were, has not been ascertained; but the teeth of some Hindoos, even in early life, are as much worn away as those of the Egyptians. The latter, as a general rule, are remarkably free from decay, and in a number of instances the whole set remains unbroken. There are various examples in which the teeth appear to have been extracted; thus reminding us of the statement of Herodotus, that there was a class of physicians whose attention, like that of our modern dentists, was bestowed exclusively upon these organs.

The Nose.—A review of the preceding Anatomical details, and a glance at the accompanying delineations, will serve to show that the form of the nose in the Caucasian series was straight, or slightly aquiline, as in the Hindoo; more prominent, as in the Pelasgic tribes; and long, salient, and aquiline, as in the Arabian race, and more especially in the Semitic nations of that stock.

It may be here observed, that the nasal bones have in many instances been more or less broken in forcing a passage through the ethmoid bone, for the purpose of removing

* "Dentes vegrandes, et incisorum quoque coronæ crassé cylindricæ magis aut obtusé conicæ, quam scalpriformes." *Decas prima*, p. 12. See also Trans. Royal Soc. of London, 1794.

† *Prichard*, Researches, Vol. II., p. 250.

the brain. This operation, which appears to have been almost uniformly practised at Thebes, was comparatively unusual at Memphis; for of the twenty-six heads from the latter necropolis, five only are perforated; while of the fifty-five Theban crania, all are perforated but two; and in a third the ethmoid is so little broken that the brain could not have been removed through the orifice. I moreover detect three instances of complete perforation of the nose, in which the brain had been extracted through the foramen magnum, by cutting the neck half across behind; the bandages being folded over the incision. The absence of the ethmoidal perforation in the oldest heads from Memphis, and in many others of a later date from the same necropolis, leads me to suppose that the brain may have been primitively removed through the foramen magnum; and that its extraction through the nose, as already suggested, may have been a subsequent refinement of the embalming art. Again, the different provinces of Egypt may have had peculiar and conventional details in this as in other usages; for all the heads from Ombos and Maabdeh have the ethmoidal opening; all those from Abydos and Debôd are without it; while of the four from Philæ, one is perforated and three are not.

Denon long ago pointed out a peculiarity of the Egyptian profile, as seen in the remarkable distance between the nostrils and the teeth. This feature, with a small receding chin, is of frequent occurrence both in the mummies and on the monuments.

Position of the Ear.—Every one who has paid the least attention to Egyptian art, has observed the elevated position which is given to the ear; and I have examined my entire series of heads, in order to ascertain whether this peculiarity has any existence in nature, but I can find nothing in them to confirm it. The bony meatus presents no deviation from the usual relative arrangement of parts; but the cartilaginous structure being desiccated, and consequently contracted, may not afford satisfactory evidence. Clot Bey and other authors have remarked an elevation of the ear in some modern Copts; and the traveller Raw, quoted by Virey, notices the same feature in the Hindoos, and it is said also to exist in degree in the Jews. There may, therefore, be *some* foundation for this peculiarity of Egyptian sculpture and painting; but I feel confident that in nature it is nothing more than an upward elongation of the auricular cartilages, without any modification of the bony meatus. It has also occurred to me that the appearance in question may be sometimes owing to the remarkable vertical length of the upper jaw in some heads (those represented Plate IV., Fig. 2, and Plate V., Fig. 2, for example,) in which it is manifest that the ear would possess a remarkable elevation in respect to the maxillary bones, without being any nearer to the top of the head than usual. These hints may possibly afford some clew to a satisfactory explanation of an almost invariable rule of Egyptian art.

Dr. Prichard (Researches Vol. II., p. 251,) has given an abstract of some observations made by M. De La Malle, on the mummies contained in the Museum of Turin. "In the skulls of these [six] mummies, as well as in many others brought from the same country, although the facial angle was not different from that of European heads, the meatus auditorius, instead of being situated in the same plane with the basis of the nose, was found by M. De Malle to be exactly on a level with the centre of the eye"! Unless M. De Malle is an anatomist, and accustomed to comparisons of this kind, I can imagine

that he might be deceived by the mere position in which the head was placed for inspection; for the more the face is drawn downward, the higher will be the relative position of the ear, until it may be brought on a level either with the nostrils or the eye, at option. I am the more disposed to offer this suggestion because we are told that in the mummies in question "the facial angle was not different from that of European heads." I need hardly remark, however, that the higher the external meatus of the ear, the less will be the facial angle; so that M. De Malle's two observations manifestly contradict each other.

In the annexed plates the reader will find seventy-four accurate delineations of mummied heads, among which he will search in vain for the alleged peculiarity of the Egyptian ear. It is equally absent in the Pelasgic, Egyptian, Semitic, and Negroid forms: and yet the Egyptians, on their monuments, bestowed it alike on the people of all nations, of all epochs, and of every condition in life. See Plate XIV.

Complexion.—On this point our evidence is, perhaps, less conclusive than on most others connected with Egyptian ethnography. Yet, meagre as it may seem, we cannot pass it by without a few remarks.

Herodotus, in the passage already cited, (p. 115,) speaks of the colour of the Egyptians as if it were black; yet this is evidently a relative, and not an absolute term. This remark applies, also, to the hackneyed fable of the two black doves, who are said, in mythological language, to have flown from Egypt, and established (at least one of them) the oracle of Delphi. Here, again, Herodotus supposes that because the doves were black, they must have represented Egyptian personages. But the Greeks, observes Maurice, called every thing black that related to Egypt, not excepting the river, the soil, and even the country itself; whence the name Ερμοχνμιος—the black country of Hermes.

Again, in reference to the statement of Herodotus, on which I have already, perhaps, too largely commented, it may be well to give the evidence of another eye-witness, that of Ptolemy the geographer, who is believed to have been born in Egypt. He wrote in the second century of our era, and his observations must consequently have been made something more than five hundred years later than those of Herodotus. His words are as follow:—"In corresponding situations on our side of the equator, that is to say, under the tropic of Cancer, men have not the colour of Ethiopians, nor are there elephants and rhinoceroses. But a little south of this, the northern tropic, the people are *moderately dark*, (ηρεμα τυγχανυσι μελανες,) as those, for example, who inhabit the thirty Schæni, (as far as Wady Halfa, in Nubia,) above Syene. But in the country around Meroë they are already sufficiently black, and *there we first meet with pure Negroes.*"*

Here is ample evidence to prove that the natural geographical position of the Negroes was the same seventeen centuries since as it is now; and for ages antecedent to Herodotus, the monuments are perfectly conclusive on the same subject. I could, therefore, much more readily believe that the historian had never been in Egypt at all,† than admit the literal and unqualified interpretation of his words which has been insisted on by some, and which would class the Egyptians with the Negro race.

* Ptolemæi Geog. Lib. I., cap. ix., as quoted in Edinburgh Review, Vol. LX. p. 312.

† Did any one ever read the EUTERPE for the first time without some misgivings of this kind? I ask this question with a profound respect for the venerable historian and traveller.

On the monuments the Egyptians represent the men of their nation red, the women yellow; which leads to the reasonable inference that the common complexion was *dark*, in the same sense in which that term is applicable to the Arabs and other southern Caucasian nations, and varying, as among the modern Hindoos, from comparatively fair to a dark and swarthy hue. "Two facts," says Heeren, "are historically demonstrated; one, that among the Egyptians themselves there was a difference of colour; for individuals are expressly distinguished from each other by being of a darker or lighter complexion: the other, that the higher castes of warriors and priests, wherever they are represented in colours, pertain to the fairer class."

That the Ethiopians proper, or Meröites, were of a dark, and perhaps very dark complexion, is more than probable; and among other facts in support of this view, we find that the mother of Amunoph III., and wife of Thotmes IV., who was a Meröite princess, is painted black on the monuments. Thus the different complexion of the great divisions of the Egyptian nation must sometimes have been blended, like their physiognomical traits, even in the members of the royal family.

It is not, however, to be supposed that the Egyptians were really *red* men, as they are represented on the monuments. This colour, with a symbolic signification, was conventionally adopted for the whole nation, (with very rare exceptions,) from Meröe to Memphis. Thus, also, the kings of the Greek and Roman dynasties are painted of the same complexion.*

Professor Rosellini supposes the Egyptians to have been of a brown, or reddish-brown colour, (rosso-fosco,) like the present inhabitants of Nubia; but, with all deference to that illustrious archæologist, I conceive that his remark is only applicable to the Austral-Egyptians as a group, and not to the inhabitants of Egypt proper, except as a partial result of that mixture of nations to which I have already adverted, and which will be more fully inquired into hereafter.

The well known observation of Ammianus Marcellinus, "Homines Ægyptii *plerique subfusculi* sunt, et atrati," is sufficiently descriptive, and corresponds with other positive evidence, in relation to the great mass of the people; and when the author subsequently tells us that the Egyptians "blush and grow red," we find it difficult to associate these ideas with a black, or any approximation to a black skin.†

The late Doctor Young, in his Hieroglyphical Literature, has given a translation of a deed on papyrus of the reign of Ptolemy Alexander I., in which the parties to a sale of

* It is a curious fact observed by Rosellini and others, that the Greeks painted some of their divinities red, as Jupiter and Pan; and even Venus herself appears to have been sometimes represented of the same colour. *Monumenti Civili*, II., p. 169.

† "By saying that the Egyptians, *for the most part*, are of a brownish or somewhat brown colour, and of a tanned and blackened hue, the writer shows that this was not the case equally, at least, with all of them; and the expression *subfusculi* and *atrati* are very different from *nigri* or *atri*."—Prichard, Researches, II., p. 232.

"Tra le specie d'uomini non affatto neri di pelle, e di fattezze diversi da quelli che noi siam soliti chiamare Africani, furono gli antichi Egizi: e quando Erodoto afferma che i Colchi erano una colonia d'Egitto, perché dessi pure avevano nero colore, non vuolsi già intende rigorosamente di quel colore, che proprio è dei Neri; ma tale ci lo chiama per rispetto al colore dei Bianchi e dei Greci stessi; e perché veramente l'incarnato degli Egiziani al nero in qualche modo si avvicinava. Noi lo diremmo con più giustezza color fosco; e questo epiteto diedero anche i Latini agli abitanti dell 'Egitto, come si legge in Properzio: "An tibi non satis est *fuscis* Egyptus alumnis?"—Rosellini, Mon. Civ., II., p. 167.

land at Thebes are described in the following terms:—"Psammonthes, aged about 45, of middle size, dark complexion and handsome figure, bald, round-faced and straight-nosed; Snachomneus, aged about 20, of middle size, sallow complexion, round-faced and straight-nosed; Semmuthis Persinei, aged about 22, of middle size, sallow complexion, round-faced, flat-nosed, and of quiet demeanour; and Tathlyt Persinei, aged about 30, of middle size, sallow complexion, round face and straight nose, the four being children of Petepsais of the leather-dressers of the Memnonia; and Necheutes the less, the son of Azos, aged about 40, of middle size, sallow complexion, cheerful countenance, long face and straight nose, with a scar upon the middle of the forehead." In another deed of the same epoch, also translated by Dr. Young, an Egyptian named Anophris is described as "tall, of a sallow complexion, hollow-eyed and bald."

Independently of the value of the other physical characters preserved in these documents, the remarks on complexion have a peculiar interest; for they show that among six individuals of three different families, one only had a dark complexion, and that all the rest were sallow.

From the preceding facts, and many others which might be adduced, I think we may safely conclude, that the complexion of the Egyptians did not differ from that of the other Caucasian nations in the same latitudes. That while the higher classes, who were screened from the action of a burning sun, were fair in the comparative sense, the middle and lower classes, like the modern Berbers, Arabs, and Moors, presented various shades of complexion, even to a dark and swarthy tint, which the Greeks regarded as black in comparison with their own. To these diversities must also be added others incident to a vast servile population, derived from all the adjacent nations, among which the sable Negro stood forth in bold and contrasted characters.

Dr. Wiseman, after a critical examination of the evidence in reference to this mooted question, has arrived at the following philosophical conclusion :—"It is not easy to reconcile the conflicting results thus obtained from writers and from monuments; and it is no wonder that learned men should have differed widely in opinion on the subject. I should think the best solution is, that Egypt was the country where the Greeks most easily saw the inhabitants of interior Africa, (the Negroes,) many of whom, doubtless, flocked thither and were settled there, or served in the army as tributaries or provincials, as they have done in later times; and *thus they came to be confounded by writers with the country where alone they knew them, and were considered part of the indigenous population.*"*

External Configuration.—On this subject I have nothing to add but the following external measurements,† (taken with my own hands,) derived from each group, and embracing all the denuded adult crania excepting two of the Semitic form.

* Lectures on the connexion between Science and Revealed Religion, p. 102, 2d edit.

These remarks will also serve to explain why Aristotle has placed the Egyptians and Negroes in the same national category; which is not more surprising than his referring the Thracians to the Mongolian race, and attributing to them a *red* complexion.

† The *longitudinal diameter* is measured from the most prominent part of the os frontis, between the superciliary ridges, to the extreme end of the occiput.

The *parietal diameter* is measured between the most distant points of the parietal bones, which are, for the most part, the protuberances of these bones.

Table I. Pelasgic Group.

	No. in Cat.	Plate.	Longitud. Diameter.	Parietal Diameter.	Frontal Diameter.	Vertical Diameter.	Inter-mastoid Arch.	Inter-mastoid Line.	Occipito-Frontal Arch.	Horizontal Periphery.
Thebes,	856	IX.	7.5	5.6	4.5	5.2	15.1	4.2	15.6	21.
Thebes,	859	VI., 5.	7.1	5.1	4.3	5.3	14.1	4.1	14.5	20.
Thebes,	850	VI., 4.	7.4	5.3	4.3	5.4	15.	4.3	15.3	20.5
Thebes,	893	VI., 3.	7.2	5.4	4.4	5.3	14.6	4.1	14.7	20.3
Abydos,	817	V., 3.	7.1	5.7	4.5	5.4	15.6	3.9	15.3	20.5
Memphis,	803	III., 8.	7.5	5.6	4.3	5.	14.8	4.	14.9	20.8
Memphis,	808	II., 1.	7.4	5.7	4.8	5.1	15.	4.	14.9	21.
Memphis,	816	III., 5.	7.4	5.1	4.3	5.5	15.	4.	15.1	20.6
Memphis,	802	III., 7.	6.8	5.2	4.3	5.4	13.9	4.2	14.	19.
Memphis,	812	II., 3.	6.8	5.5	4.5	4.8	13.6	4.	14.1	19.9
Memphis,	815	II., 2.	7.	5.2	4.1	5.4	14.6	3.9	15.	19.9
Memphis,	799	III., 4.	7.2	5.7	4.2	5.	14.9	3.7	14.8	20.4
Memphis,	814	II., 5.	7.3	5.8	4.6	5.2	15.4	4.3	15.5	20.8
Memphis,	805	II., 7.	7.4	5.	3.9	5.3	14.4	3.9	15.	19.8
Memphis,	838	I., 1.	7.5	5.5	4.4	5.5	14.7	4.	15.	20.7
Memphis,	837	I., 2.	7.8	5.7	4.6	5.7	15.	4.1	15.6	21.2
Memphis,	798	III., 6.	6.9	5.5	4.4	5.1	14.2	4.1	14.5	19.5
Memphis,	825	III., 9.	7.5	5.7	4.3	5.3	15.	4.2	15.	20.7
Memphis,	840	II., 9.	7.3	5.4	4.6	5.2	14.8	4.1	15.	20.6
Philæ,	821	XII., 6.	6.9	5.2	4.4	4.9	14.	4.	14.	19.5
Highest in the series,			7.8	5.8	4.8	5.7	15.6	4.3	15.6	21.2
Mean,			7.25	5.44	4.38	5.25	14.6	4.05	14.85	20.33
Lowest in the series,			6.8	5.1	3.9	4.8	13.6	3.7	14.	19.

The *frontal diameter* is taken between the anterior inferior angles of the parietal bones.

The *vertical diameter* is measured from the fossa between the condyles of the occipital bone, to the top of the skull.

The *inter-mastoid arch* is measured, with a graduated tape, from the point of one mastoid process to the other, over the external table of the skull.

The *inter-mastoid line* is the distance, in a straight line, between the points of the mastoid processes.

The *occipito-frontal arch* is measured by a tape over the surface of the cranium, from the posterior margin of the foramen magnum to the suture which connects the os frontis with the bones of the nose.

The *horizontal periphery* is measured by passing a tape around the cranium so as to touch the os frontis immediately above the superciliary ridges, and the most prominent part of the occipital bone.

Table II. Egyptian Group.

	No. in Cat.	Plate.	Longitud. Diameter.	Parietal Diameter.	Frontal Diameter.	Vertical Diameter.	Inter-mastoid Arch.	Inter-mastoid Line.	Occipito-Frontal Arch.	Horizontal Periphery.
Thebes,	857	VII., 3.	7.	5.	4.	5.3	14.6	3.8	14.9	19.6
Thebes,	849		7.1	5.5	4.4	5.2	14.8	3.9	14.6	20.1
Thebes,	860	VI., 1.	7.	5.4	4.4	5.3	14.7	4.	14.2	20.
Thebes,	848	VII., 4.	7.1	5.2	4.1	5.	14.2	3.7	15.	20.
Thebes,	847	VII., 5.	6.8	4.8	3.9	5.	13.5	4.	13.9	18.8
Thebes,	851	VII., 1.	7.	5.3	4.5	5.	14.	4.	14.	19.7
Thebes,	853		7.5	5.6	4.3	5.	15.5	4.1	15.	20.7
Abydos,	820	V., 2.	7.5	5.5	4.	5.5	15.2	3.9	15.7	20.9
Abydos,	819	V., 1.	7.3	5.3	4.	5.	14.6	4.	14.6	19.8
Memphis,	806	II., 4.	6.6	5.9	4.	4.8	14.6	4.2	13.6	19.7
Memphis,	811	III., 1.	6.9	5.5	4.	4.8	14.5	3.7	14.4	19.5
Memphis,	809	III., 2.	7.3	5.3	4.2	4.9	14.3	3.9	14.5	20.6
Memphis,	795		7.	5.3	4.1	5.1	14.9	3.9	14.4	19.5
Memphis,	796		6.7	5.4	4.3	4.8	14.3	3.9	13.9	19.5
Memphis,	797		6.8	5.2	4.4	5.1	14.5	4.	14.2	19.4
Debôd,	827	XII., 9.	7.3	5.2	4.5	4.9	13.7	4.2	14.9	20.5
Debôd,	826	XIII.	7.	5.1?	4.	5.4	14.	4.	14.5	19.
Debôd,	829	XII., 8.	7.	5.1	4.3	5.	13.7	3.6	13.7	19.5
Thebes,	867	VIII., 8.	7.8	5.4	4.3	5.5	15.	4.3	15.5	21.4
Thebes,	861	VII., 2.	7.3	5.3	4.4	5.5	14.7	4.2	15.2	20.3
Memphis,	810	II., 6.	7.2	5.5	4.4	5.2	14.7	3.8	15.2	20.7
Thebes,	889	VI., 7.	7.5	5.2	4.4	5.8	14.4	4.3	15.2	20.5
Ombos,	832	XII., 5.	7.4	5.4	4.5	5.	15.	4.2	14.9	20.5
Highest in the series,			7.8	5.9	4.5	5.8	15.5	4.3	15.7	21.4
Mean,			7.15	5.32	4.21	5.14	14.5	4.	14.6	20.1
Lowest in the series,			6.6	4.8	3.9	4.8	13.5	3.6	13.6	18.8

Table III. Negroid Group.

	No in Cat.	Page or Plate.	Longitudinal Diameter.	Parietal Diameter.	Frontal Diameter.	Vertical Diameter.	Inter-mastoid Arch.	Inter-mastoid Line.	Occipito-Frontal Arch.	Horizontal Periphery.
Thebes,	864	Page 109,	7.	5.1	4.2	5.4	14.4	3.3	14.6	19.6
Thebes,	885	" "	7.	5.5	4.5	5.1	14.4	3.5	14.8	19.7
Thebes,	858	" "	7.4	5.3	4.5	5.	14.6	4.4	14.6	20.5
Thebes,	852	" "	7.2	5.1	4.4	5.2	14.	4.3	14.3	19.5
Thebes,	869	" "	7.4	5.4	4.1	5.5	13.9	4.3	15.5	20.
Maabdeh,	834	IV., 2	6.4	5.5	4.2	5.1	13.8	4.	13.8	18.7
Mean,			7.05	5.3	4.3	6.2	14.2	4.	14.6	19.6

These measurements, it must be confessed, possess merely an isolated interest until they can be compared with those derived from the other races of men.* Meanwhile I

* I have been engaged for several years past in obtaining and arranging a series of measurements of the nature here indicated, under the title of Craniometrical Tables; but it will be readily conceived that the difficulty of procuring the requisite materials, renders the progress of such an undertaking extremely slow and uncertain.

give them as I find them, and in the hope of being able to institute the desired comparisons on some future occasion.

Stature.—Mr. Pettigrew's measurements seem to prove, what the size of the head also indicates, that the Egyptians were of the middle stature. He met with no instance which, even enveloped in its bandages, would measure more than five feet six inches. Perhaps, however, sufficient allowance has not been made for the contraction of the joints, and especially of the intervertebral substance, which in a state of complete desiccation, would diminish the length of the body at least two inches. In the year 1833, I purchased of the heirs of the late Senior Lébolo, a dilapidated mummy from Thebes, of which I prepared the skeleton, now preserved in the Anatomical Museum of the University of Pennsylvania. It measures about five feet ten inches, and is in every respect beautifully developed excepting the cranium, which is small in proportion and of indifferent conformation.*

Age.—It is a familiar fact that the mummies of children are rarely found in the Egyptian catacombs, at least in comparison with those of adults; a circumstance which has not been satisfactorily explained.

Champollion Figeac observes that the Egyptians were a long-lived people, as proved by their funereal inscriptions which frequently speak of the dead as having passed the age of fourscore years; a remark which derives some confirmation from the following table, wherein the crania in my possession are proximately classed according to their respective ages:—

From one year old to five,	3
From five to ten,	5
From ten to fifteen,	4
From fifteen to twenty,	9
From twenty to thirty,	27
From thirty to forty,	25
From forty to fifty,	18
From fifty to sixty,	2
From sixty to seventy,	2
From seventy to eighty,	3
From eighty to ninety,	2
	100

Having thus identified, in the catacombs, the remains of the various people who constituted the Nilotic family, we proceed in the next place to trace them on the monuments of Egypt and Nubia; and as the value of this comparison must depend on the fidelity of the artists who have copied the paintings and bas-reliefs, we shall derive the following illustrations, with one or two exceptions, from the admirable works of Champollion, Rosellini, and Hoskins.

* I have reason to believe that this cranium, which I obtained separate from the rest of the mummy, belonged to another Egyptian skeleton subsequently procured from the same source.

1. THE EGYPTIANS.

The monuments from Meroë to Memphis, present a pervading type of physiognomy which is every where distinguished at a glance from the varied forms which not unfrequently attend it, and which possesses so much nationality both in outline and expression, as to give it the highest importance in Nilotic ethnography. We may repeat that it consists in an upward elongation of the head, with a receding forehead, delicate features, but rather sharp and prominent face, in which a long and straight or gently aquiline nose forms a principal feature. The eye is sometimes oblique, the chin short and retracted, the lips rather tumid, and the hair whenever it is represented, long and flowing.

This style of features pertains to every class, kings, priests, and people, and can be readily traced through every period of monumental decoration, from the early Pharaohs down to the Greek and Roman dynasties. Among the most ancient and at the same time most characteristic examples, are the heads of Amunoph the Second, and his mother, as represented in a tomb at Thebes,* which dates, in Rosellini's chronology, seventeen hundred and twenty-seven years before our era. In these effigies all the features are strictly Egyptian, and how strikingly do they correspond with those of many of the embalmed heads from the Theban catacombs!

Fig. 1.

Fig. 2.

A similar physiognomy preponderates among the royal Egyptian personages of every epoch, as will be manifest to any one who will turn over the pages of Champollion and Rosellini. The head of Horus (Plate XIV., Fig. 2,) is an admirable illustration, while in the portraits of Rameses IV., and Rameses IX., (Plate XIV., Fig. 6 and 7,) the same lines are apparent, though much less strongly marked. How admirably also are they seen in the subjoined juvenile head, (Fig. 1,) which is that of a royal prince, copied from the very ancient paintings in the tomb of Pehrai, at Eletheias.† So also in the face of Rameses VII., (Fig. 2,) who lived perhaps one thousand years later in time.

* Champollion, Monumens de l'Egypte, Tom. II., plate 160, fig. 3.

† Rosellini, M. C., plate CXXXIII., fig. 3.

1

2

I observe that the priests almost invariably present this physiognomy, and in accordance with the usage of their cast, have the head closely shaven. When coloured they are red, like the other Egyptians. The subjoined drawing, (No. 1,) which is somewhat harsh in outline, is from the portico of one of the pyramids of Meroë,* and is probably one of the oldest human effigies in Nubia. They abound in all the temples of that country, and especially at Semneh, Dakkeh, Soleb, Gebel-Berkel, and Messoura.†

From the numberless examples of similar conformation, I select another of a priest from the bas-relief at Thebes, which is remarkable for delicacy of outline and pleasing serenity of expression.‡ (No. 2.)

So invariably are these characters allotted to the sacerdotal caste, that we readily detect them in the two priests who, by some unexplained contingency, become kings in the twentieth dynasty. Their names read Amensi-Hrai-Pehor and Phisham on the monuments; and the accompanying outline is a fac-simile of Rosellini's portrait of the latter personage, who lived about eleven hundred years before the Christian era.§ In this head the Egyptian and Pelasgic characters appear to be blended, but the former preponderate. (No. 3.)

The last outline, (No. 4,) represents a modification of the same type, that of the *Harper* in Bruce's tomb at Thebes. The beautiful form of the head and the intellectual character of the face, may be compared with similar efforts of Grecian art. It dates with Rameses the IV.‖

1 2 3 4

* Hoskins' Travels in Ethiopia, plate XI.

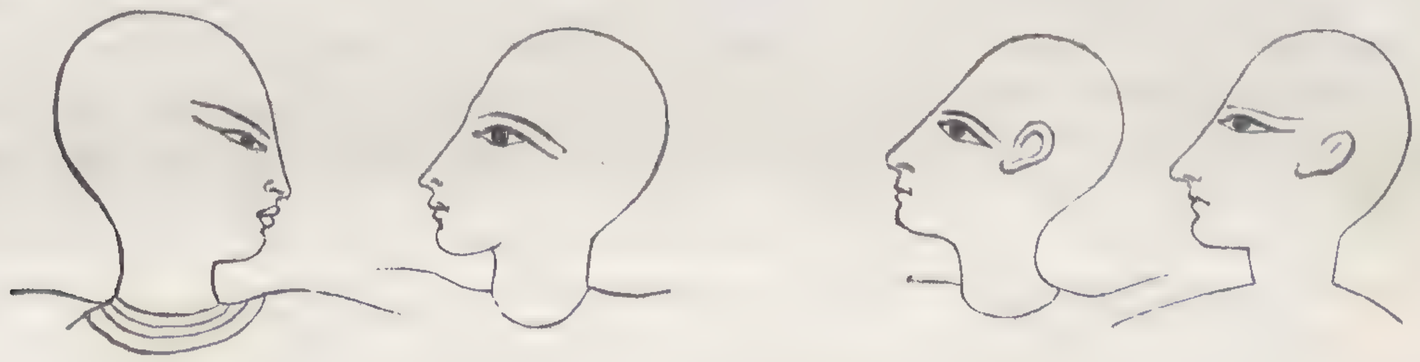
† Cailliaud, plate XVI. to XX. For the use of the only copy of this work now in the United States, I am indebted to the politeness of Colonel Pleasanton, of this city.

‡ Rosellini, Monumenti, M. C., plate CXXXIII.

§ Champollion, Figéac, Egypte Ancienne, p. 356.

‖ Rosellini, M. C., plate XCVII., and Wilkinson's Topography of Thebes, p. 109.

As I believe this to be a most important ethnographic indication, and one which points to the vast body of the Egyptian people, I subjoin four additional heads of priests from a tomb at Thebes, of the eighteenth dynasty. We are forcibly impressed with the delicate features and oblique eye of the left hand personage, and with the ruder but characteristic outline of the other figures, in which the prominent face, though strongly drawn, is essentially Egyptian.*



The annexed outlines, which present more pleasing examples of the same ethnographic character, are copied from the tomb of Titi, at Thebes, and date with the remote era of Thotmes IV.† They represent five *fowlers* in the act of drawing their net over a flock of birds. The long, flowing hair is in keeping with the facial traits, which latter are also well characterized in the subjoined drawings, derived from monuments of different epochs and localities.

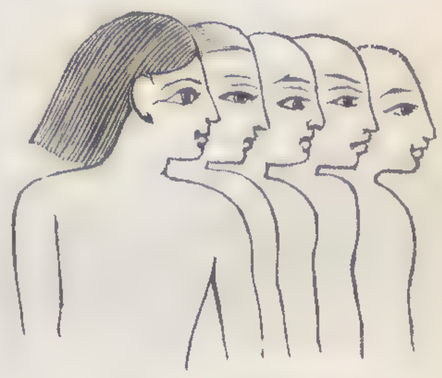


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

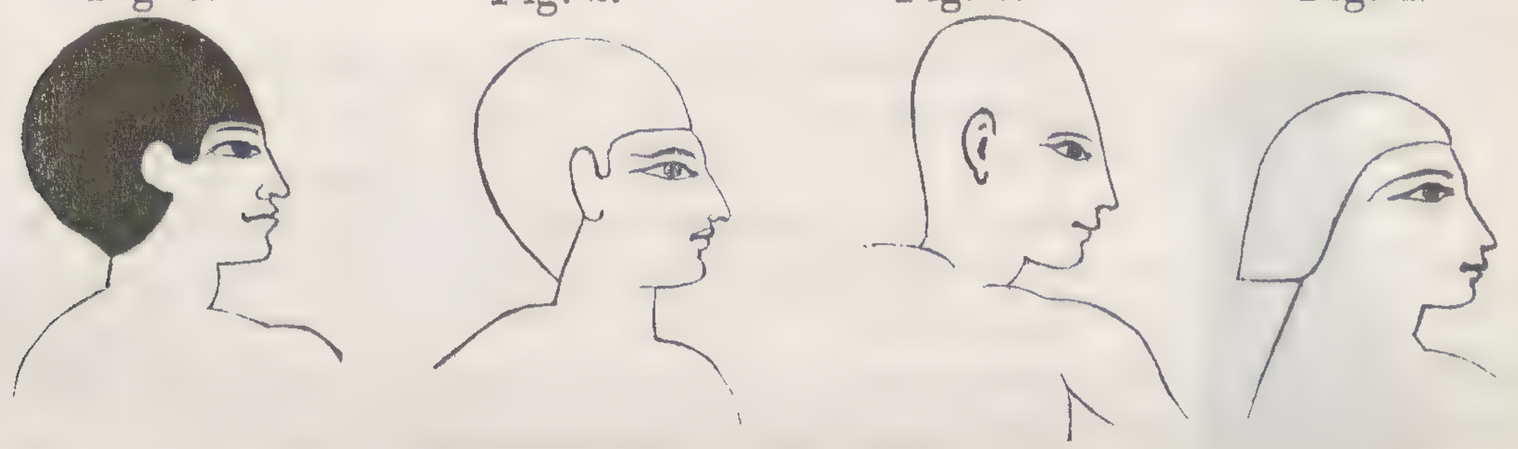


Fig. 1, is the head of a *weaver*, from the paintings in the very ancient tomb of Roti and Menoph at Beni-Hassan, wherein the same cast of countenance is reiterated without number.‡

Fig. 2, a *wine-presser*, is also from Beni-Hassan, and dates with Osortasen, more than 2000 years before the Christian era.§

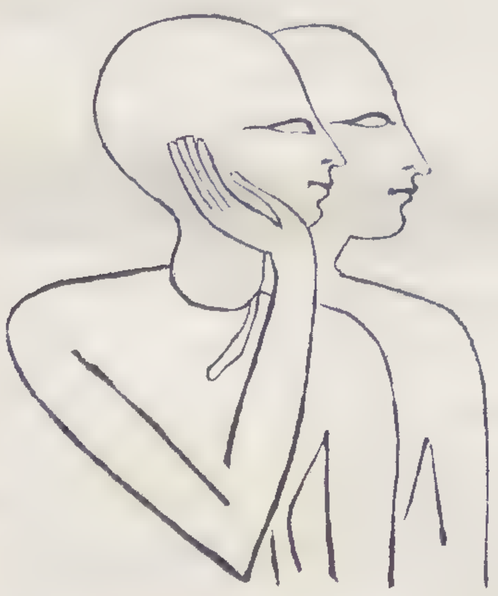
Fig. 3, is a *cook*, who in the tomb of Rameses the Fourth, at Thebes, is represented with many others in the active duties of his vocation.‖

Fig. 4. I have selected this head as an exaggerated or caricatured illustration of the same type of physiognomy. It is one of the *goat-herds* painted in the tomb of Roti, at Beni-Hassan.¶

* Rosellini, M. C. Plate 126.
† Idem. Vol. 1, Plate 4.
‡ Idem. M. C. Plate 41.
§ Idem. M. C. Plate 37.
‖ Idem. M. C. Plate 86.
¶ Idem. M. C. Plate 29.

The most recent of these last four venerable monuments of art, dates at least 1450 years before our era: the oldest belongs to unchronicled times; and the same physical characters are common on the Nubian and Egyptian monuments down to the Ptolemaic and Roman epochs.

The peculiar head-dress of the Egyptians often greatly modifies and in some degree conceals their characteristic features; and may at first sight lead to the impression that the priests possessed a physiognomy of a distinct or peculiar kind. Such, however, was not the case, as a little observation will prove. Take, for example, the four following drawings from a Theban tomb, in which two mourners have head-dresses and two priests are without them. Are not the national characteristics unequivocally manifest in them all?*



In addition to the copious remarks already made in reference to the hair, we cannot omit the annexed picture from a tomb in Thebes, which represents an Egyptian woman in the act of lamentation before the embalmed body of a relative, while the long, black hair reaches even below the waist.†

It is thus that we trace this peculiar style of countenance in its several modifications through epochs and in localities the most remote from each other, and in every class of the Egyptian people. How different from the Pelasgic type, yet how obviously Caucasian! How varied in outline, yet how readily identified! And if we compare these features with those of the Egyptian series of embalmed heads, are we not forcibly impressed with a striking analogy not only in osteological conformation, but also in the very expression of the face? Compare, for example, the head on page 109. Observe, also, the six figured skulls, Plate VII; Plate XII., Fig. 4; Plate X., Fig. 4; Plate VIII., Fig. 9, and the numerous accompanying illustrations, and no one, I conceive, will question the analogy I have pointed out. This type is certainly *national*, and presents to our view the *genuine Egyptian physiognomy*, which, in the Ethnographic

* Rosellini, M. C. Plate 132, Fig. 1.

† Idem. Plate 127, Fig. 1.

scale, is intermediate between the Pelasgic and Semitic forms. We may add, that this conformation is the same which Prof. Blumenbach refers to the *Hindoo* variety in his triple classification of the Egyptian people.* And this leads us briefly to inquire, who were the Egyptians?

It is in the sacred writings only that we find any authentic records of the primeval migrations of our species. "In the general allotment of territories to the offspring of Noah," observes Mr. Gliddon, "Egypt, by the concurrent testimony of all Biblical commentators, was assigned to Mizraim, the son of Ham, as a domain and for an inheritance;" whence Egypt has, from the remotest times, been called by the names of Mizraim and Ham, or *Khemé*. Mr. Gliddon adds, that "although the name of Mizraim has not yet been found in hieroglyphic legends, there is abundant scriptural evidence to prove that the country was called Mizraim and Mitzar by the Jews; while at the present day throughout the east, Egypt and Cairo are universally known by the cognate appellation of *Muss'r*."†

Entering Africa by the Isthmus of Suez,‡ the children of Ham were ushered into the fertile valley of the Nile, a region prepared by nature for settled communities and a primeval civilization. In a country bounded by the Red Sea on the one side, and by a wilderness on the other, and presenting but a narrow strip of land for its inhabitants, laws would at once become necessary for mutual protection; and we may suppose that while one portion of the Mizraimites embraced these social restrictions, another, impatient of control, passed beyond the desert barrier on the west, and spreading themselves over the north of Africa, became those nomadic tribes to which the earliest annals give the name of LIBYANS.§ It follows from this view of the question, that we suppose the Egyptians and Libyans to have been cognate people; that the former were the aboriginal‖ inhabitants of the valley of the Nile; and that their institutions, however modified by intrusive nations in after times, were the offspring of their own minds.

It will, however, be very naturally objected that among the Egyptians no gradations are apparent between barbarism and refinement. "It is a remarkable fact," says Sir G. Wilkinson, "that the first glimpse we obtain of the history and manners of the Egyptians, shows a nation already advanced in the arts of civilized life; and the same customs and inventions that prevailed in the Augustan era of that people, after the accession of the eighteenth dynasty, are found in the remote age of Osortasen, the contemporary of

* Trans. Royal Society of London, 1794, passim, and Plate 16, Fig. 2, of that work.

† Ancient Egypt, p. 46, 47.

‡ The learned Dr. Beke reverses the route, and supposes that the "Cushite descendants of Ham" first settled on the western side of the Arabian Peninsula, crossed thence into Ethiopia, and descending the Nile, became the Egyptians of after times.—Origines Biblicæ, 1, p. 162.

§ I use the terms Libyan and Ethiopian as they are handed down to us from antiquity. "Speaking with all the precision I am able," says Herodotus, "the country I have been describing is inhabited by four nations only; of these *two are natives* and two are strangers. The natives are the *Libyans* (Λιβυες) and the Ethiopians, (Αιθιοπες); one of which possesses the northern, the other the southern parts of Africa. The strangers are the Phenicians and the Greeks."—Melpomene, 197. In the days of Herodotus nomad Libyans still inhabited the vicinity of Avaris.

‖ I use the word *aboriginal* in this place with some reservation. It has been supposed by learned authorities that Africa was peopled by Negroes before the Hamitic tribes entered that country. I do not suppose Ham to have been the progenitor of the Negro race; and, with Dr. Wiseman, Mr. Lawrence and many others, I regard as a "conjecture" in Science, that doctrine which would attribute the physical gradations between the white man and the Negro to any other natural process than that of direct amalgamation.—Lawrence, Lectures on Zoology, 8th edit. p. 264. Wiseman, Lectures, 2d edit. p. 158. Beke, Origines Biblicæ, Tom. I., p. 162.

Joseph." How then could a branch of the Libyan race, a people so comparatively obscure, have become the mighty Egyptian nation? How could families of mankind so widely different in their intellectual manifestations, have been derived from a cognate stock? To which we reply, that the Egyptians and Libyans were not in this respect more widely separated than were the Saracens under the Caliphs, and the wandering Bedouins; yet, both these were branches of the Arabian race. Egypt may perhaps be regarded as the intellectual centre of the posterity of Ham.

The evidences of these opinions, it must be confessed, are as yet few in number. That the Libyan or Berber speech was once the language of all northern Africa has long been maintained by Ritter, Heeren and Shaler, and by Mr. Hodgson in his very interesting Letters from Algiers, during the period in which he held the United States consulate in that regency.* Prof. Ritter (whose work I have not seen) asserts that the Amazirgh, or Berber language, as detected by certain prefixes and affixes peculiar to it and the Coptic tongue, is to be found across the whole breadth of the continent, from the Red Sea to the Canary Isles; and he supposes, too, that the Hazorta tribes, like the old Bejas and modern Bishareens, were originally of the same parent stock. To these evidences we may add those of Prof. Vater, who traced some affinity between the Berber and the Coptic and Amharic, but not sufficient to lead to satisfactory results.

I have before me an obliging communication from Mr. Hodgson, in which he informs me, that he also discovered what he believed to be incontrovertible evidence of the Berber origin of the Bishareen language, before he had read the work of Prof. Ritter; and in an essay just published on the Foulahs of central Africa, he reiterates the opinion early expressed by him, that the Berber or Libyan tongue was spoken in the valley of the Nile, prior to the existence of the Coptic or monumental language; a theory which, he further remarks, is in accordance with the nature of things and the probable course of events.

"Whilst the positive records of modern history," observes Mr. Hodgson, "show that the Coptic tongue has been obliterated from the map of Egypt within the short period which has elapsed since the Saracenic invasion, need we wonder that so few traces remain of the language of that country in primeval and unrecorded times? These vestiges, however, have been detected by me, and, I think, with a strong degree of probability, in the mythologic and geographical names transmitted to us from the earliest periods of Egyptian history. The meaning of Ammon, Thebes, Themis, and Nile, and of Heliopolis (Tadij) and Apollinopolis (Etfu) have been explained from the modern Berber language; and the very name of *Hykshos*, who were called shepherds, means also shepherds in Berber.†

"These etymologies serve, at least, as tokens of the existence of the Libyans in the

* These Letters, which are addressed to Peter S. Duponceau, Esq., are contained in the fourth volume of the Transactions of this Society; and to this source the reader is referred for a mass of interesting details which is necessarily excluded in this place. The valuable communications of Mr. Shaler, also addressed to Mr. Duponceau, are published in the second volume of the same work.

† "The phrase *a shepherd fed his flock*, is thus rendered in that language:—*amiksa iksa thikhsi*. These words, moreover, constitute a beautiful illustration of the genius of the language. In *amiksa* we have the formative particle *am;* and in *thikhsi* there is the feminine prefix *th*, a peculiarity alike of the Berber and the Coptic. The prefixes and suffixes *t*, *th*, are Berber indications throughout the whole extent of north Africa." Vide also Hornemann, Voyage, Vocab. p. 431.

valley of the Nile, at a period anterior to that of the monumental Egyptians. I have, also, found grammatical affinities between the Coptic and the Berber, which suggest that the monosyllabic elements of the former have been imposed upon the Berber syntax, and, therefore, that the Coptic is posterior in nationality to the Berber."

Leaving this important and difficult philological inquiry to the abler hands of Mr. Hodgson, (for it involves some points on which I am not qualified to judge, and therefore offer no opinion,) we may merely remark, that the Berber theory is farther countenanced by various mythological considerations, among the most remarkable of which is the supposed Libyan origin of several Egyptian divinities.

Particular communities of the Libyans are familiar in history by the names of Mauritanians, Numidians and Getuli. Respecting the physical characteristics of these people, history is nearly silent; yet there is sufficient evidence to prove, that they possessed those features which are now called Caucasian, independently of any modifications that may have resulted from their long intercourse with Phenician colonies, and the Romans, Arabs and Vandals in later periods of time. The Libyans were a nomadic and warlike people; they were habitually employed in the Carthagenian armies, and in the earlier ages contended with the Egyptians themselves; for we learn from a passage in Manetho, (Cory, Frag. p. 100,) that in the remote age of Necherophes, of the third dynasty, the Libyans revolted from the Egyptians, but were soon again subdued. The monuments record similar triumphs in the reigns of Osortasen 1st., Thotmes 1st., Rameses the 3d, and indeed in almost every dynasty down to the Ptolemaic epoch, when Libya continued to be an Egyptian province. In fact, the Libyans hung upon the skirts of Egypt as the Goths did upon Rome; and until the researches of the hierologists identified the Hykshos or shepherd kings with an Asiatic people, there was strong presumptive evidence that these ruthless invaders were, at least in part, no other than the Libyans themselves.*

The Libyans are represented in our day by the various and motley Berber tribes, who under the names of Tuaricks, Kabyles and Siwahs, inhabit both north and south of Mt. Atlas; and in their physical characters combine the Caucasian physiognomy with various shades of complexion, from a fair skin to a dark and tawny hue.

"The Kabyles," says Mr. Shaler, "are a white people, of middle stature, muscular, athletic and active, but never corpulent; and are of lively, social manners and of ingenious dispositions. Many of them are of light complexions, with hair approaching to flaxen, resembling rather the peasants of the south of Europe than the inhabitants of Africa."† Then come the darker Tuaricks, men of fine mould and adventurous spirit, but nomadic, unfeeling and vindictive.

Dr. Oudney, who saw them in great number, describes them in nearly similar terms, but assures us that under favourable circumstances their good, sound sense, would soon render them "a shining people." It is curious, also, to note the following remark of the same intelligent traveller: "On almost every stone, in places they frequent, the Tuarick characters are hewn out. It matters not whether the letters are written from right to

* In Jeremiah Cush and *Phut* are names of African nations; while in hieroglyphics Libya is called *Nephaiat*, the "country of the nine bows." The root of Nephaiat being *Phut* (in Coptic a bow) connects the Libyans with *Phut*, the son of Ham, (Gen. x. 6,) and confirms the affiliation of the Libyans and Egyptians. See Gliddon, Anc. Egypt, p. 25, 27, 41.

† Sketches of Algiers, p. 91. Capt. Lyon's observations are to the same purpose. *Trav. p.* 109.—Denham and Clapperton, p. 73.

left, or *vice versa*, or horizontally," a singular accordance with the graphical system of the ancient Egyptians.* It would therefore appear, that these roving descendants of the Libyan race possess, even now, some vestiges of that innate love of sculpture which was cultivated on so grand a scale by the temple-builders of the Nile.

Yet farther south are the darker Berber tribes called Siwahs or Shouas, who are said by Major Denham to have "free open countenances, with aquiline noses and large eyes; their complexion is a light copper colour. They possess great cunning with their courage, and resemble, in appearance, some of the best favoured Gypsies in England." Dark as they are, he remarks that "in comparison with the Negresses they are almost white." They are vastly numerous throughout all Soudan, Houssa and Bornou, and the Sultan of the latter country has no less than 15,000 of them in his army.†

In other instances, although they are few in comparison, the Berbers assimilate more to the Negro on account of the proximity of the two races; a remark which is especially made by Dr. Oudney in reference to the Tuaricks of Mourzouk, who have black and curling hair, but which, "from a Negro mixture, is inclined to be crispy."‡

Here then are the various gradations of the Caucasian type which appear to have marked the ancient Egyptians, together with a degree of that intermixture of the Negro race which is revealed in the catacombs, and perpetuated in the modern Coptic population.

In connexion with this subject, it is curious to remark that the Guanches of the Canary Islands were a branch of the Berber or Libyan stock; and the singular perfection to which they brought the art of embalming, long since led to the supposition that they might have been affiliated with the Egyptians. The only Berber skull in my possession is of this insular branch of that race, and like the one figured by Professor Blumenbach, bears a striking resemblance to the Egyptian conformation.§

The Ethiopians.—Every one who has paid the slightest attention to the present inquiry, is aware of the entire vagueness of the name *Ethiopia* (Cush) as used by the ancients; which, like *India* in modern times, was applied to countries very remote from each other, and whose inhabitants were remarkably dissimilar. Thus Austral-Egyptians, Hindoos, Arabs, and Negroes, and even the Egyptians themselves, have each in turn been embraced in this designation.

Our present inquiry, however, relates to that people who occupied the valley of the Nile, from Philæ to Meroë, and perhaps yet farther south; a region at the present time inhabited by the Nubians, Senàaree and the Abyssinians, with all those endless varieties of race which necessarily result from immemorial proximity to the Negro countries. It is a point of great interest and importance to ascertain the physical characteristics of the *aboriginal* communities of this branch of the Nilotic family; but they become at an early

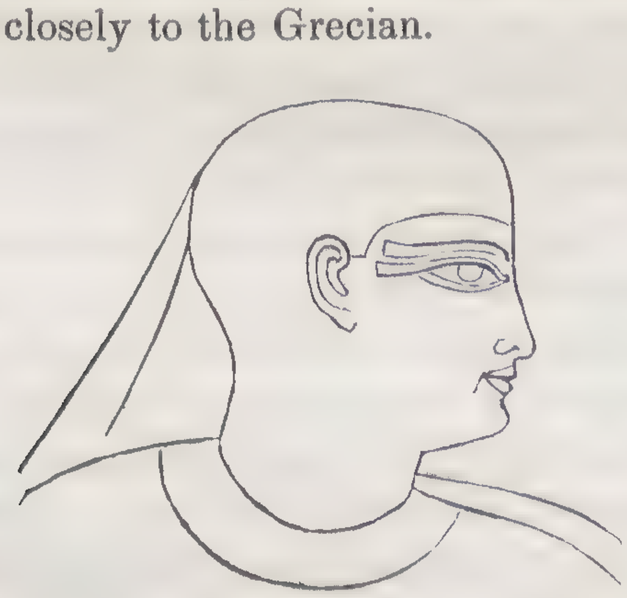
* Denham and Clapperton, Introd. p. 67. To give some idea of the number of the Tuaricks, these gentlemen mention that no less than two thousand were executed at Sackatoo, in Houssa, on a single occasion, for a predatory irruption into the territories of the Negro sultan of that country.—*Journey from Kano to Sackatoo*, p. 107.

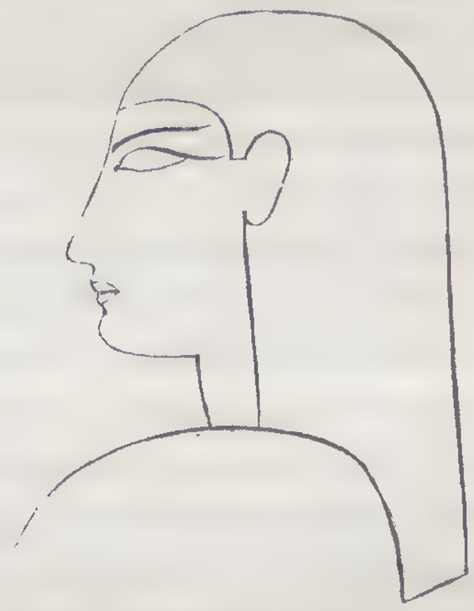
† Ibid. p. 941, 213, 237, 263, 315.

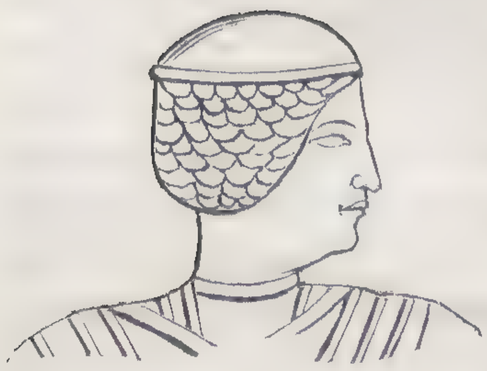
‡ Denham and Clapperton, p. 50. See also Hornemann, Voy. en Afrique, p. 147.—All the Tibboo tribes appear to be Negroes modified by intermixture with the Arabs and Berbers who surround them.

§ For the funereal rites of the Guanches as compared with those of the Egyptians, see Bertholet, "Mémoires sur les Guanches," in Memoires de la Societé Ethnologique de Paris, Tome I.—See also Blumenbach, Decad. Cran. Tab. XLII.

period so blended with exotic nations that their distinctive features must be chiefly derived from the monuments, unless the catacombs of Meroë should hereafter throw additional light on the subject. Of the monumental evidence we have already spoken: we have seen that the proper Egyptian physiognomy, the same which abounds at Thebes, is every where conspicuous on the tombs and temples of the Meröite * or monumental Ethiopians. That these people had no affinity, even in the remotest times, to the Negro race, would appear from the evidence already adduced, and also from other facts which remain to be noticed. Among the paintings of the Grand Procession (epoch of Thotmes IV.,) at Thebes, Mr. Hoskins remarks that the Negro is represented with all the characteristic features of his race, but that the Ethiopians are painted red like the Egyptians, having their hair dressed in curls above their foreheads, and in ringlets upon their shoulders.† (Plate XIV., Fig. 22.) So also in the voyage of Scylax, B. C. 360, the Ethiopians are described as a beautiful people, with long hair and beard; and the distinguished English traveller just quoted remarks that the heads sculptured on the pyramids of Meroë have a nearly European profile. Two of these, which are associated with the same legend, are represented by the subjoined figures.‡ The one to the left hand (that of an unknown king) has mixed lineaments, neither strictly Pelasgic nor Egyptian; while the right hand personage, who appears to be a priest doing homage, presents a countenance which corresponds in essentials to the Egyptian type, although the profile approaches closely to the Grecian.







The annexed head, also of a king, and bearing some resemblance to the one above figured, is copied from Mr. Waddington's § drawing of a group over the portico of the Fifth Pyramid at Djebel Birkel (the ancient Armada) supposed to be among the oldest sculptures in Nubia.

We have already alluded to the opinion of Prof. Ritter and others, that the old Bejas and the modern Bishareens were derived from the Berber or Libyan stock of nations. I am ready

* I use the word *Meroë* in a comprehensive sense for all the ancient civilized region south of Egypt.

† Travels in Ethiopia, p. 329. Wilkinson, M. and C. Vol. I., Plate LXII.

‡ Idem. Plate X.

§ Travels in Ethiopia, Plate XIV. See also Cailliaud, Voy. à Meroë, and Hoskins, Plate XXIX.

to go farther and adopt the sentiment of the learned Dr. Murray, that the Egyptians and monumental Ethiopians "were of the same lineage, and probably descended from a Libyan tribe."

This view of the case at once reconciles the remark of Champollion, Rosellini, Heeren and Rüppell, that they could detect the present Nubian physiognomy every where on the monuments; but at the same time it supersedes the necessity of their inference that Nubia was the cradle of civilization, and that the arts, descending the river, were perfected in Egypt. The latter question cannot be definitively settled until the archæologists decide on the relative antiquity of the Egyptian and Nubian monuments. In the present state of the discussion, however, the preponderance of facts is greatly in favour of Egypt.*

Without attempting to discuss this intricate question on the present occasion, I will merely add my conviction that the original Meröites were neither Arabs nor Hindoos, (although, as we shall explain, they became greatly modified by these nations in after time) but that they formed an unequivocal link in the Libyan chain of primitive Caucasian nations.

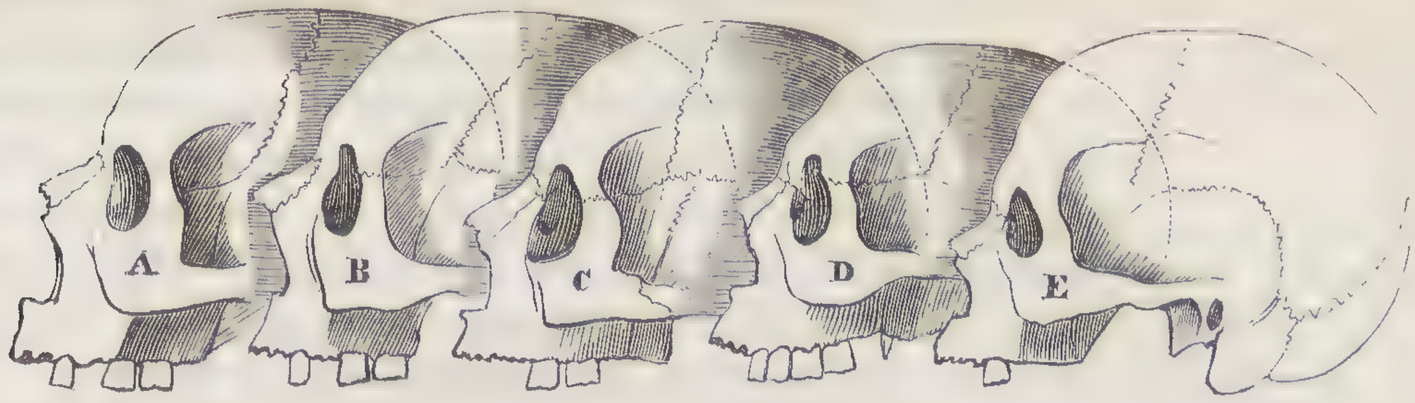
THE FELLAHS.—These people, also called Arab-Egyptians, are found every where in the valley of the Nile, of which they are the principal cultivators. "Their heads," observes Mr. Lane, "are a fine oval, the forehead of moderate size, not high, but generally prominent; their eyes are deep sunk, black and brilliant; the nose is straight and rather thick; the mouth well formed; the lips are rather full than otherwise; the teeth particularly beautiful, and the beard is commonly black and curly, but scanty."† They have a yellowish complexion, and are, in general, a strong, well formed people. There can be little question that the Fellahs are a mixture of the Arab stock with the old rural population of Egypt; an amalgamation which dates chiefly from the seventh century of our era, (A. D. 640,) when the Saracens under Amrou conquered the country, and separated it from the Greek empire. The constant influx of Arab population from that time to the present must have more or less modified the features of the previous inhabitants; and yet even now we are assured by Jomard and others, that the Fellahs of upper Egypt present a striking resemblance, in all respects, to the monumental paintings and sculptures. "A l'aspect des hommes du territoire d'Esné, d'Ombos, ou d'Edfoû, ou des environs de Selsélé, il semblerait (pour emprunter une image du plus célèbre des ecrivains modernes) que les figures des monuments de Latopolis, d'Ombos, ou d'Apollinopolis Magna, se sont détachées des murailles, et sont descendues dans la campagne."‡

Mr. Gliddon's kindness has furnished me with eight Fellah skulls, of which five are represented in the subjoined wood-cuts. Three of them only are adult, and all are small, and present a remarkable prominence of the face (termed *prognathous* by Dr. Prichard;) a feature which appears exaggerated in the following outlines, on account of the occiput and teeth being drawn on the same plane.

* See Gliddon, Ancient Egypt, *passim*.

† Modern Egyptians, Vol. II., p. 32.

‡ Jomard, apud Mengin, Hist. de l'Egypte, p. 408. To this valuable memoir the reader is referred for various additional analogies which are unavoidably omitted on the present occasion.



The large receding forehead,* so characteristic of both Arabs and Fellahs (and, as we have seen, of the several links of the great Semitic chain of nations,) is well marked in most of these crania, together with the long and salient nose.

That several of them are in feature more Arab or even Semitic than Egyptian (A, C,) is obvious, and the reason has been already given; yet how far the Fellahs will compare, in the details of physical character, with the true Libyan or Berber tribes, remains for future investigation. When this shall have been accomplished, it may be found that the Fellahs preserve the nearest approximation to the ancient Egyptians of any people now inhabiting the valley of the Nile.

2. THE PELASGIC RACE.†

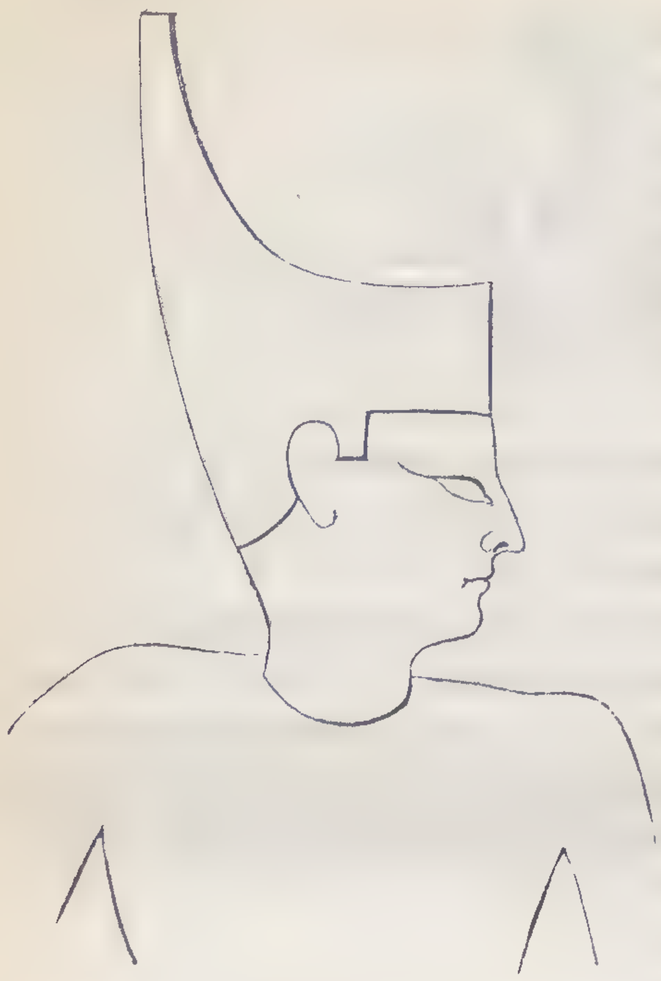
The proofs that people of the Pelasgic stock were in early times the rulers of Egypt is attested by history and the monuments. Manetho states that the XVI. dynasty was composed "Of thirty-two Hellenic shepherd kings, (ποιμενες Ελληνες βασιλεις,‡) who reigned five hundred and eighteen years." It is not to be supposed that the number of either kings or years is accurately given: all that is necessary to our purpose is the main fact of Hellenic dominion in Egypt, which is moreover sustained by monumental evidence; for happily the tombs and temples preserve the portraits of the Nilotic sovereigns, executed with so much individuality of feature and expression, as to leave little doubt of the general fidelity of the likenesses. These effigies, which are now indelibly preserved in the great works of Champollion and Rosellini, present the following interesting results.§

* "Le front haut et large, découvert et un pen fuyant."—Jomard.

† In addition to the few remarks already made in reference to my use of this term, I may observe that the Pelasgi were generally regarded as the aboriginal inhabitants of Thessaly; but their warlike and roving propensities led them to extend their migrations in various directions, until we find it difficult, if not impossible, to distinguish between them and the affiliated tribes of Dacians, Macedonians and Thracians. At one period they ranged nearly the whole country from Illyria to the Black Sea, and gave the name of Pelasgia to all Greece; and, as every one knows, the Greeks or Hellenes were their lineal descendants. See Prichard, Researches, Vol. III., and Mrs. Gray's History of Etruria, Vol. I., p. 86.

‡ Cory, Frag. p. 114.

§ For the proofs that these effigies are really portraits of the persons represented, the reader is referred to Rosellini's chapter entitled, "Iconografia dei Faraouni e dei re Greci de 'Egitto," in his *Monumenti*, M. S., Vol. II., p. 461. Portraits of the same king sometimes differ very considerably from each other, I grant, but the instances are few in comparison, and may have been intended to designate different periods of life; nor are these differences greater than we are accustomed to see in the physiognomy of modern kings, as represented on their respective coins and medals. But even if it could be demonstrated that the Nilotic paintings are not portraits, it would not diminish their ethnographic value, for they at least delineate the characteristic physiognomy of the Egyptians. See also, Champollion, "Lettres écrites de l'Egypte et de la Nubie."



The oldest identified human effigy now extant is that on the *Tablet of Wady Halfa*, preserved in the gallery of Florence.* This venerable relic, which has been satisfactorily proved to date more than two thousand two hundred years before the Christian era,† represents Osortasen the First in the form of Ammon, and receiving from the god Monthou (Mars) the people of Lybia bound with cords as captive nations.

The features of the king are strictly Pelasgic; and the facial angle, (allowing for the unnatural elevation of the ear,) measures upwards of eighty degrees. It is also remarkable that this head is strikingly like those of the Ptolemaic sovereigns of Egypt, and especially corresponds in every feature with the portrait of Ptolemy Euergetes II., although eighteen centuries elapsed between their respective reigns. We therefore recur to our proposition, that whether this effigy be a portrait or not, it at least proves that the artists of those primeval times derived their ideas of the human countenance from Caucasian models.

The next of these heads which can be identified with its epoch, is that of Amunoph I. This again presents a fine cast of European features; such, in fact, as would embellish a Grecian statue; and yet this monarch reigned in the valley of the Nile, and held his court in Memphis more than eighteen hundred years before the birth of Christ. (Plate XIV., Fig. 1.) And if from this remote period we trace the physiognomy of the kings and queens of the subsequent reigns, we perceive among them many equally beautiful models, some of which are not inferior to the *beau ideal* of classic art. Take, for example, the heads of Menepthah and Rameses III., in the character of priest,—Rameses X., Rameses XI., and Amenmeses,—the queens Nofre-Ari, and Nitocris, and the daughter of Phisham (or Pihmé,) the regent priest, and let me ask among what people we shall find more graceful facial lines, or more varied intellectual expression? (Plate XIV.)

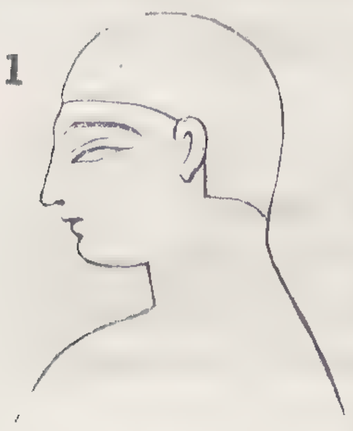
It may be suggested that in some of these heads the Pelasgic character is not wholly unmixed, and especially in reference to Amunoph the First. In this instance there is something of the Egyptian, or, as Professor Blumenbach would express it, the Hindoo physiognomy. I wish it to be understood, however, that I do not assert all these sovereigns to have been of the Pelasgic or Japetic stock; for some of them, as Rameses the Third, and Menepthah the First, are on other occasions represented with decidedly Egyptian features. These mixed and varied Caucasian lineaments may perhaps have been derived from the antecedent Hellenic kings, who in giving place again to the native Egyptians, must doubtless have left their national characteristics more or less blended with those of the indigenous families.

* Champollion, Monuments, Tom. I., Plate I. The annexed figure is greatly enlarged from Champollion's drawing. See also Rosellini, M. R., Plate XXV., in which the *eye* is wanting.

† Champollion Figéac, Egypte, p. 293.

The following heads, which are all of strictly Caucasian proportions, are *fac simile* copies from Rosellini. They are derived from groups of figures engaged in various mechanical and other operations, as represented in the tombs and temples of Thebes, and various other parts of Egypt.

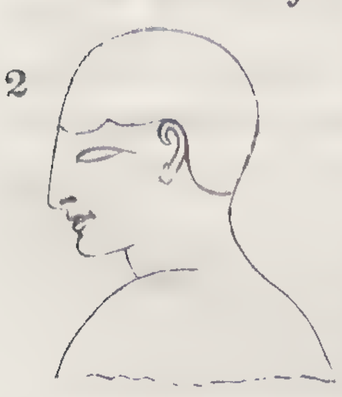
1



The annexed head, (1) that of a reaper, is one of a great number executed in bas-relief in the celebrated tombs of Eilethyas, which possess a greater interest and value in ethnography on account of their venerable antiquity; for they date with and before the eighteenth dynasty, and consequently are at least three thousand six hundred years old.* The great French work, (Déscription de l'Egypte,) contains an extended series of illustrations from the same remarkable tombs in which a similar cast of features is almost every where apparent.†

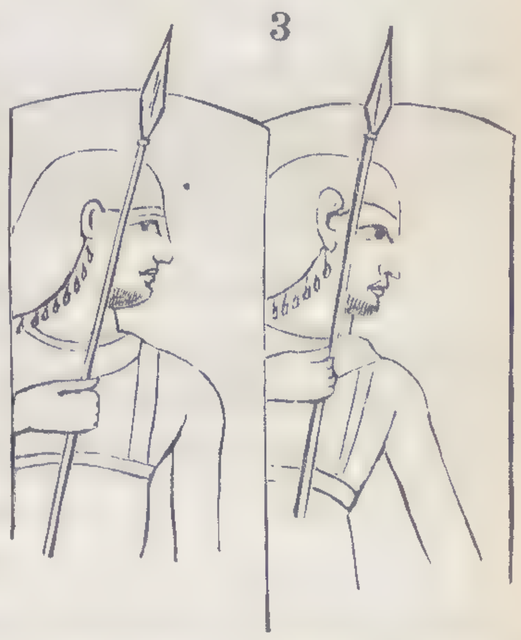
The same style of face is not less decidedly expressed in another head (2) from Rosellini,‡ of which the original painting is preserved in the Royal Gallery at Florence. It represents an artisan. How admirably do the features conform to the Grecian type!

2



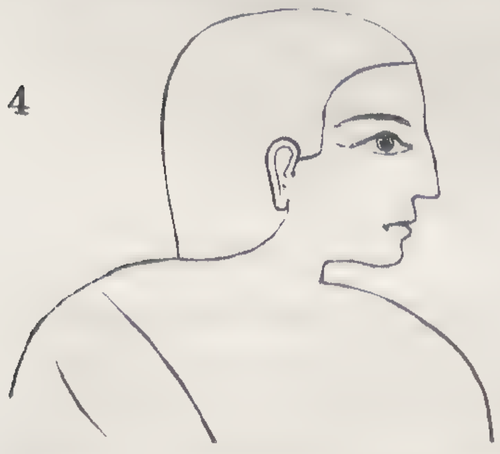
I repeat the remark, and yet more emphatically, in reference to the admirable battle scene at Abousimbel, of the age of Rameses the Third, wherein eighty soldiers are depicted in a single group, each one bearing a shield and spear.§ Are they mercenaries from one of the Hellenic tribes? I select the two subjoined examples; (3) for a close resemblance pervades them all. Here again every line is Grecian; and yet when these paintings were executed, the wandering Pelasgi had hardly begun to associate themselves in civilized communities, and the arts of Greece were unknown.

3



Paintings of a similar ethnographic character are seen in profusion at Beni-Hassan, whence is derived the annexed outline, representing one of the leather-dressers of that group. The straight line for the nose and forehead are strictly Pelasgic, and conform in most respects to the other facial traits. (4)

4



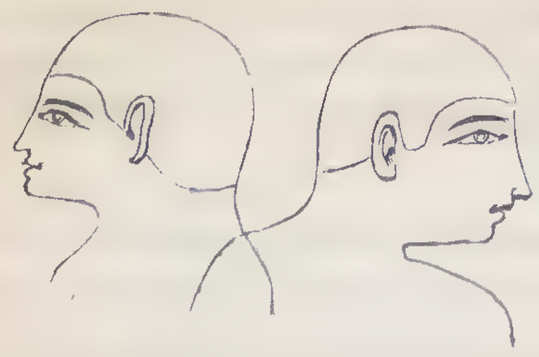
The same general physiognomy is often much more rudely expressed, as in the tomb of Imai, at Gizeh, which is of the age of Shufo, of the fourth dynasty, and consequently the period of disputed chronology. Rude as these figures are, and identified with an humble sphere of life, they have the Caucasian form, and partake of the same ethnographic lineaments with the more elaborately finished

* Rosellini, M. C., Plate 33.

† Antiquités, Tom. I., Plate 68.

‡ Rosellini, M. C., Plate 13.

§ Idem. M. R., Plate 96.



outlines delineated above. It may be observed, with respect to Egyptian art, that while the bas reliefs are for the most part executed with remarkable beauty and precision, the paintings, owing to the use of a single colour, and the absence of perspective or shading, are often coarse and defective; and the two annexed drawings will serve to illustrate this negligent style of art.

It is thus that we trace the Pelasgic type of feature and expression through all the various castes of the Egyptian population, beginning with kings and ending with peasants and plebeians. The illustrations have been purposely selected from those remote times wherein chronology becomes confusion, down to the later periods of recorded history,—a vast period of thirteen centuries, of which the latest date looks back nine hundred years before the birth of Christ!

People of Pelasgic features and complexion are often seen on the monuments as prisoners taken in war. One of these is copied, Plate XIV., Fig. 23. It is from Abousimbel, and dates with Rameses III. The very fair skin, regular features and black hair seem to point to a nation of southern Europe. The nose is nearly straight, and on the same line with the forehead, although the latter recedes more than is consistent with our ideas of the Grecian profile.*

3. THE SEMITIC RACE.†

That people of this great family were numerous in Egypt is amply attested both by sacred and profane history; and the proximity of their respective countries necessarily brought the Semitic and Egyptian communities into frequent contact for war or for peace. This fact is abundantly proved by the monuments. The Jewish people, however, appears, for the most part, to have been admitted into Egypt upon sufferance; for the Exodus, and all subsequent annals, are conclusive on this subject.

Those peculiar lineaments which, from very remote times, have characterized some of the Semitic nations, have been already noticed. How many of these nations possessed these physical characters, cannot now be determined; but it is probable that all partook of them in degree. It is in the temple of Beyt-el-Wàlee, in Nubia, in paintings of the age of Rameses II., (B. C. 1579,) that we meet with one of the earliest unquestionable delineations of these people. (Plate XIV., Fig. 24.)

* Rosellini, M. R., Plate 158.

† The Semitic race extended from the Mediterranean sea on the west to the confines of Persia on the East, and doubtless possessed great variety of feature and complexion. They derive their collective name from Shem, "from whom, in the table of nations in the book of Genesis, entitled Toldoth Beni Noah, many of them are declared to have descended." Prichard, Researches, II., p. 208, 2d ed. The principal of these nations, adds Dr. Prichard, were those of Elam, to the north-west of the Persian Gulf; the Assyrians; the Chasdim, or Chaldeans, who are the ancestors of the Hebrews and Arabs; the Lydians; and the Syrians, or people of Aram. They are also called, collectively, Syro-Arabian nations.

The Jews were immensely numerous in Egypt during the Ptolemaic and Roman epochs. *Vide* Josephus, Book XII., chap. ii.—Sharpe, Egypt under the Romans, p. 13.

An additional illustration is that given in the margin. It is also preserved in the temple of Beyt-el-Wàlee, and is of the same date as the head above described. These people are

generally represented as enemies or bondsmen; nor have I any doubt that the figures in the celebrated *Brickmaker's scene*, in the tomb of Rekshari, at Thebes, of the age of Thotmes IV., are those of a Semitic nation, and, in all probability, Hebrews. Their features obviously correspond with those of the latter people; and their scanty beards, which have been made an objection to this view of their nationality, may be regarded as a compulsory badge of captivity. Perhaps the most Hebrew *portrait* on the monuments is that of Aahmes-Nofre-Ari, Queen of Amunoph I., who is said by the hieroglyphists to have been by birth a Meröite. (Plate XIV., Fig. 13.) Semitic features, as we have already shown, are occasionally found among the embalmed heads from the catacombs; in proof of which I refer, with confidence, to Plate XI., Fig. 2; and also, though less strongly marked, to Plate II., Fig. 8, Plate VI., Figs. 2 and 8, and to Plate XII., Figs. 1 and 2.

My studies have not qualified me for philological comparisons and inferences, but I cannot forbear introducing the following views of the learned Dr. Lepsius, on account of their direct bearing upon this interesting question. Speaking of the Egyptian and Coptic tongues, he says:—"I have now discovered, in the essence of the language itself, not only that there is no appearance whatever of any grammatical change, and that it possesses, perhaps in a higher degree, that principle of stability so peculiar to the Semitic dialects, but also that it has preserved in its formation traces of a higher antiquity than any Indo-Germanic or Semitic language wherewith I am acquainted, which traces will therefore be most unexpectedly important even for these two families. At the same time the Coptic cannot be termed either Semitic or Indo-Germanic. It has its own peculiar formation, though, at the same time, *its fundamental relationship with these two families* is not to be mistaken."*

The Arabs.—The southern or peninsular Arabs are a people of middle stature, with a complexion varying from a sallow hue to a very dark colour. They have sharp, bold features, a rather prominent face, and a straight or gently aquiline nose. The head is, moreover, comparatively small, and the forehead rather narrow and sensibly receding; to which may often be added a meagre and angular figure,† long, slender limbs, and large knees. Some tribes are also remarkable for the small stature of the men, which, according to Burckhardt, does not exceed five feet two or three inches; while, with a thick head of hair, they possess a short, thin, and pointed beard.‡

Such are some of the Bedouins; but the most formidable Arab tribes have always been the Hemyarites of Yemen; a restless and enterprising people, whose migrations have been

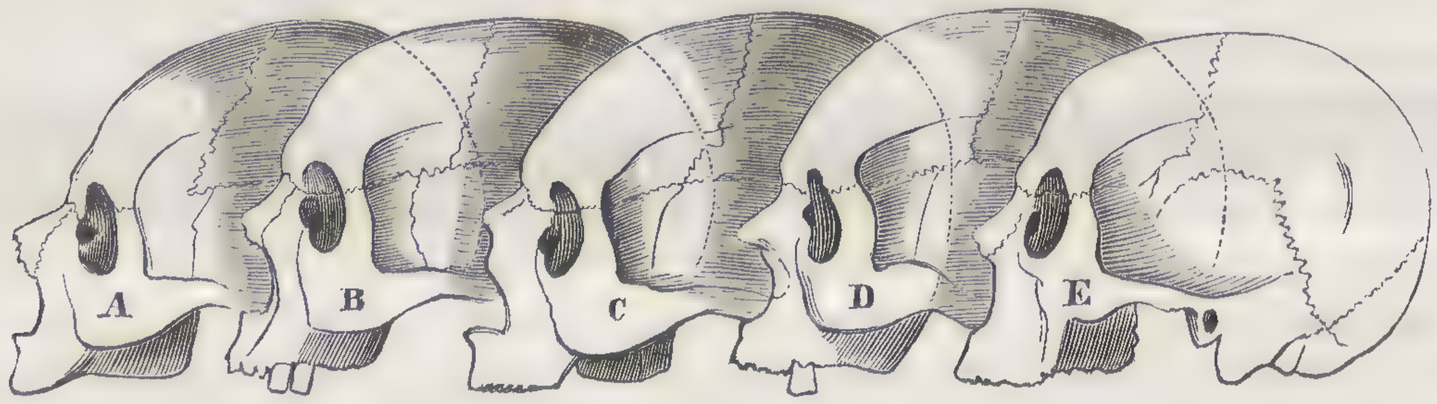
* Letter to the Chev. Bunsen. See Wiseman's Lectures on Science and Revealed Religion, 2d edit., p. 62; and a note at the end of that most learned and instructive work, "on the conformity between the Semitic and the Indo-European grammatical forms."

† "Toutes leurs formes sout anguleuses," says Denon; "leur barbe courte et à mèches pointues." Voyage en Egypte, I., p. 92.

‡ Bedouins and Wahabys, p. 28.—Clot Bey, Aperçu generale de l'Egypte, I., p. 161.

chiefly directed to Africa, and especially to the valley of the Nile; a region which they have invaded and more or less occupied from the earliest times, through the reigns of the Pharaohs, Ptolemies, and Cæsars, down to a recent period of our own era. What language can be stronger than that of Juba, (about the commencement of our own era,) that the inhabitants of the valley of the Nile, from Philæ to Meroë, were not Ethiopians, but Arabs? So, also, in the days of Strabo, half the population of *Coptos* itself was made up of the same people.

The cranial resemblances between the Arabs and ancient Egyptians impressed me forcibly from the commencement of my inquiries; which last I have been able to prosecute in a more satisfactory manner by means of a series of Arab skulls, obtained in Egypt by Mr. Gliddon. I subjoin outline drawings of five of them, in order that the reader may judge for himself.



These skulls are all adult, and though comparatively small, give a mean internal capacity of eighty-four cubic inches, which is above the Egyptian average. The analogy, however, is greater in form than in size, as may be observed by comparing the above outlines with several of the embalmed heads from the catacombs, and especially that figured Plate VI., Fig. 7. In fact, the resemblance between the Egyptian and Arab head is so striking, that nothing but a faithful study of the monuments has satisfied me that the two nations were primitively distinct from each other; and that what I at first believed to be the *Austral-Egyptian* conformation, is no other than the Egyptian itself. Some very ancient paintings, copied by Rosellini from the temple decorations at Beyt-el-Wàlee, in Nubia, appear, also, to pertain to the Arab physiognomy. (Plate XIV., Figs. 19, 20.) In these the yellowish-red complexion indicates, we might suppose, some affinity with the Egyptian nation, while the small, pointed beard, and sharp, prominent face, point to the Arabian stock of nations. Their name reads *Tohen* on the monuments; and they pertain to the age of Rameses II., and illustrate the conquests of that monarch 1579 years before Christ.

Without entering into a philological discussion, it is worthy of remark, that the Gheez or Ethiopic language, the oldest of the known tongues of Abyssinia, is directly allied to the Arabic and Hebrew. The period of its introduction into Africa is unknown, though it probably dates far beyond our era. Moreover, among the ruins recently discovered at Hasan Ghorâb, (170 miles east of Aden,) at Sanaa, and at other places in Yemen, inscriptions have been abundantly found in the old Ethiopic tongue, which, in the opinion of the late Professor Gesenius, is a modification of the parent Hemyarite language.

These few facts, with others which will be adduced hereafter, go to prove that the Egyptian people must have been more or less blended with the Arabian race; nor can

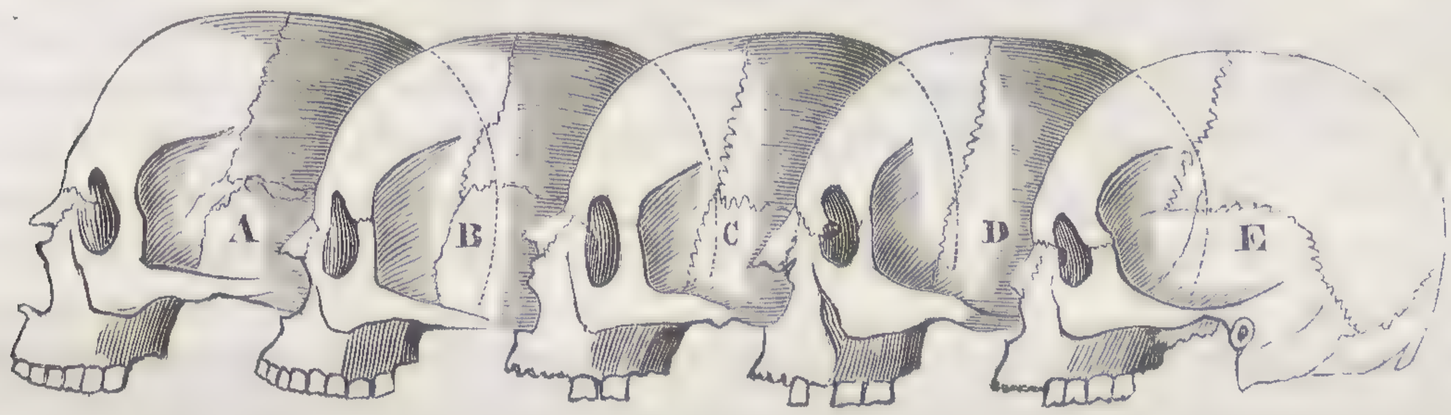
there be a question that the Meröite or Austral-Egyptian communities were composed, at least in part, of an Indo-Arabian stock engrafted on the aboriginal Libyan population.

An able but anonymous author not only asserts the Arab origin of the monumental Ethiopians, but endeavours to prove, by an ingenious series of facts and reasonings, that they were the "Blemies of history, a Bejáwy branch of the Arabian family;" that they were broken and finally dispersed by the policy of the Roman government, which, in the reign of Dioclesian, introduced Negro colonies from Kordofan; and, finally, that the Nubians of our day are not, as a nation, descended from the ancient stock. The last proposition, as a general rule, is undeniable; but the preceding conclusions are not yet susceptible of proof.*

Convinced as we are that the Egyptians were a distinct and aboriginal people, the sentiment of M. Jomard may yet become, to a certain extent, an axiom in ethnography:— "L'Arabie à été de tout temps, et elle est encore de nos jours, l'aliment de la population Egyptienne."†

4. THE HINDOOS.

I observe among the Egyptian crania, some which differ in nothing from the Hindoo type either in respect to size or configuration. I have already, in my remarks upon the ear, mentioned a downward elongation of the upper jaw, which I have more frequently met with in Egyptian and Hindoo heads than in any others, although I have seen it occasionally in all the races. This feature is remarkable in two of the following five crania, (A, B,) and may be compared with a similar form from Abydos. (Plate V., Fig. 2.)



The Hindoo head is also remarkable for its small size, its narrow form, especially in front, and often, also, for the delicacy of the osteological structure. The bones of the face, however, project more than those of the European, and there is not unfrequently a manifest eversion of the upper jaw. (B.) The nose is rather small, and the bones are variously aquiline, straight, or moderately compressed. My observations have been made on thirty-seven crania, for which I am indebted to Drs. Burrough and Carson, of this city, and to Dr. Martin and Mr. H. Piddington, of Calcutta. Of these, twenty-four are adult, varying from eighteen to eighty years of age, and give an average internal capacity of but eighty cubic inches; the largest head measuring ninety cubic inches, the smallest only sixty-nine.‡ They pertain, for the most part, to *low-caste* Bengalees.

* Edinburgh Review, Vol. LX., p. 297. † *Apud* Mengin, Hist. de l'Egypte, III., p. 406.

‡ I have stated, in my "Crania Americana," that the Hindoos appear to have the smallest heads of any existing people; and that in the Inca Peruvians the brain was but a fraction larger. Later observations, however, have led me to believe that the *Nigritos*, or aboriginal Negro race of the Indian archipelago, present a nearly parallel example.

It is in that mixed family of nations which I have called Austral-Egyptian that we should expect to meet with the strongest evidence of Hindoo lineage; and here, again, we can only institute adequate comparisons by reference to the works of Champollion and Rosellini. I observe the Hindoo style of features in several of the royal effigies, and in none more decidedly than in the head of Asharramon, as sculptured in the temple of Debôd, in Nubia. The date of this king has not yet been ascertained; but as he ruled over Meroë, and not in Egypt, (probably in Ptolemaic times,) he may be regarded as a good illustration of at least one modification of the Austral-Egyptian type.

Another set of features, but little different, however, from the preceding, is seen among the middling class of Egyptians as pictured on the monuments, and these I also refer to the Hindoo type. Take, for example, the four annexed outlines, copied from a sculptured fragment preserved in the museum of Turin. These effigies may be said to be essentially Egyptian; but do they not forcibly remind us of the Hindoo?* The mummied head figured Plate X., Fig. 6, has the same general form and cast of features.

The Hindoos are also represented on the monuments as prisoners and tribute-bearers to the kings. My drawing, Plate XIV., Fig. 21, is copied from the "Grand Procession" of Thotmes IV. The man leads a bear; an indication that he is of a foreign country, for there are no bears indigenous to Africa. Moreover, the characters of the animal, as delineated in Rosellini, are not unlike those of the celebrated grotesque species of India called by naturalists *Ursus labiatus*, which has been, in all ages, a favourite with Hindoo mountebanks. The man himself has an aquiline and pointed nose, thin beard, receding forehead, and comparatively fair complexion, which assimilate him to some Indo-Semitic or Indo-Persian tribe.

In the same celebrated scene I notice another head of the same general cast, but of a darker complexion and more delicate features, who answers yet more accurately to the type of the northern Hindoos. He wears a light dress and grass hat, and moreover leads an elephant, all of which point to a warm climate. Mr. Hoskins remarks that "the elephant must be from Ethiopia: if, therefore, they [the attendants] are Scythians, as some suppose, they must be employed as slaves bringing the produce of Ethiopia." And he concludes by suggesting that they may be white slaves of the latter country, sent as a present to the Egyptian king. This appears to me to be an involved and unsatisfactory explanation. The elephant, like the bear, is obviously an Asiatic animal, (for the Egyptians made no use of the living native species,) and it is evident that this group is merely typical of some conquered Hindoo nation, or proximate and cognate tribe.

* Rosellini, M. S. II., p. 174, 238.

Winkelman, Blumenbach, and other authors, have also been struck with these cranial resemblances; and certain physical analogies were familiar to the writers of antiquity. They are especially recorded by Strabo and Arrian, who compare the southern Hindoos to the Ethiopians, and the northern Hindoos to the Egyptians. Various shades of complexion, as we have remarked, were common to both countries, together with a small stature and slender limbs.

History, mythology and the arts discover various additional analogies between these venerable nations. Apis, the Egyptian bull, was the symbol of Osiris; and the white bull is the animal on which Siva is represented on the Indian pagodas: worship was bestowed alike on the Ganges and the Nile; both nations paid homage to the sun and the serpent; and even at the present time, the objects held in greatest veneration by the Hindoos of the Vishnu sect are the ape, the monkey, the bird called garruda, and the serpent capella. Among the symbols of superstition in each are the sphinx, the lotus, the lingam, and the cross. "The dog, sacred to Bhairava, a form of Siva, and the jackall of Durga, remind us of the barking Anubis, the companion of Osiris. The dogs of Yama, one of which was termed Cerbura, or spotted, and was feigned to have three heads, corresponds remarkably, as Mr. Wilford has observed, with the three-headed Cerberus, the dog of Pluto."*

This affinity is also recognised in their almost exclusive vegetable diet, and by the singular institution of castes. Analogies are, moreover, traced in the architecture of the two nations, whether in their monolithic temples and subterranean sanctuaries, or in the statuary and minor decorations of their stupendous temples.†

That there was extensive and long-continued intercourse between the Hindoos and Egyptians is beyond a question; and history speaks, also, of conquest and migration. Which was primitively the dominant power? The Egyptians very naturally decided this point in their own favour; for they assert that Osiris crossed Arabia to the utmost inhabited parts of India, and built many cities there. "He left, likewise," says Diodorus, "many other marks of his being in these parts, which have induced the inhabitants to believe and affirm, that this god (Osiris) was born in India."‡ Thus it appears that, in the age of Diodorus, the Hindoos not only worshipped, but claimed as original to themselves, the principal divinity of the Egyptians. There is, moreover, a passage in Syncellus which directly asserts that the Hindoos, who, as we have observed, are sometimes called Ethiopians in ancient history, formed colonies in Egypt. "Æthiopes ab Indo fluvio profecti, supra Ægyptum sedem sibi eligerunt." Heeren, from whom I derive this quotation, remarks, that as the Hindoos would necessarily arrive by sea, they would establish themselves on the coast. We grant it; but a commercial and migratory people would soon find their way to the great mart of Meroë, and thence to every part of the Egyptian provinces. It has been observed by Mr. Bonomi, that the affiliation of the Hindoos with the people of the upper Nile is confirmed by the affinity which exists

* Prichard, Egyptian Mythology, p. 35.

† Crania Americana, p. 37.

‡ Bibliotheca, B. I., C. 2. "Khem, of whom Osiris is a form, is the great deity corresponding to the Indian Siva; Phthah, of whom Horus is another form, is the Indian Brahma; and Kneph is the counterpart of Vishnu." Cory, in Harapollo, Pref., p. x.

between the Ethiopic and Sanscrit systems of writing, as pointed out by Dr. Wall and Mr. Tudor.*

Dr. Prichard, whose profound investigations into this and all other questions in ethnography, command our highest respect, while he admits that great difficulties present themselves in the present inquiry, remarks "that a common origin, if not of the races themselves, at least of the mental culture characteristic of both of them, has been proved; and that the people of India and of Egypt derived from one source the first principles of all their peculiarities of thought and action, of their religious and social observances, and civil and political institutions; and that these principles had even been developed to a considerable extent, before the nations themselves were entirely cut off from communication with each other or with a common centre."†

It has been proved by the philosophic Heeren, that Meroë was the grand emporium of the trade between the richest and most productive portions of the earth; the gold countries of eastern Africa, the spice lands of India, and the region of frankincense and precious stones in southern Arabia. He has shown that the communication between these countries was established in the most ancient periods, and continued without interruption through successive ages of time; that the ruins of Adulé, Azab, and Axum, yet mark the caravan routes between Meroë and Arabia Felix; and that Yemen, though separated from India by an open sea, is yet connected with it by nature in an extraordinary manner. "One half of the year," he adds, "from spring to autumn, the wind regularly sets in and wafts the vessels from Arabia to India; the other half, from autumn to spring, it as regularly carries them back from India to Arabia."‡

In truth, what Diodorus says, in general, of early Egyptian commerce and conquest by sea, need be no longer regarded as fabulous, although the details, like much that we glean from the remote history of all heathen nations, are to be received with circumspection. He tells us that Sesostris (Rameses III.) fitted out a fleet of four hundred ships in the Arabian gulf, with which he conquered all the countries bordering on the Erythrean sea, as far as India, whence he led an army beyond the Ganges until he again reached the ocean. This account is not likely to be *all* fable, especially since it comes from a Greek historian; and we may safely regard it as an indication of that extensive maritime enterprise in which the Egyptians engaged with the southern nations of Asia. When the Romans under the guidance of Hippalus, eighty years after their conquest of Egypt, began to trade with India by way of the Red Sea and Malabar, they only re-established the ancient route, which had been long forgotten amidst the chaos of political revolutions. In fine, if the Egyptians had been their own historians, we should probably learn that they were as familiar with India in ancient as the English are in modern times.§

* Trans. Roy. Soc. of Literature, I., p. 173. (London.)

† Prichard, Researches, Vol. II., p. 218.

‡ Ancient African Nations.—That the Indo-European race (of which the Hindoos are a branch,) has been among the most enterprising and widely distributed nations of the earth, is incontestably proved by the prevalence of the Sanscrit tongue as an element of many languages from Hindostan westward to the shores of Iceland, and eastward to the Polynesian Isles.—Malte Brun, Geography, Vol. I., p. 660.

§ It is curious to observe that although the Hindoos in our day have little intercourse with Nubia and the adjacent provinces, the circumstance is owing to a want of those incentives to commerce which existed in antiquity; but Burckhardt describes the remains of Indian traffic as now seen in Mecca and Djidda, in Arabia, where the Hindoos yet sell the manufactures and other productions of their own country.—Travels in Arabia, p. 14, 119.

While we conclude, therefore, that the Egyptians were a distinct people from either the Arabs or Hindoos, we cannot deny those resemblances which are too obvious to be mistaken, yet not to be accounted for without difficulty; nor can there be a reasonable doubt that the people of both these nations formed an important part of the once multitudinous population of Egypt.*

5. THE HYKSHOS.

There is no fact in history more familiar than the rule of the Hykshos or shepherd kings in Egypt. The word Hykshos is the same as we have seen (p. 130,) both in the Egyptian and Berber or Libyan tongues, and signified a *shepherd* or a wanderer. It was applied to all those foreigners who at different times displaced the native dynasties,—Scythians, Hellenic tribes, Phenicians, and others.

Reserving some remarks for a future part of this memoir, we shall briefly observe that there is no monumental record of more than one of these sovereignties, namely, that which was expelled by Amunoph the First of the eighteenth dynasty, about eighteen centuries before Christ. These people, whose name was held in execration by the Egyptians, are said by Herodotus and other historians to have possessed a fair complexion, blue eyes, and reddish hair. That they were of the Caucasian race there is no question; but the preceding traits apply equally to the Scythians, the Phenicians, and the Edomim or Edomites, and it is probable that the shepherd dynasties of Manetho embraced kings from all these sources.†

The portraits of these intrusive kings, as recently discovered in various parts of Egypt, not only present a physiognomy entirely different from that of the legitimate monarchs, but the symbol of their religion is also different, being "the sun, whose rays terminate in human hands," while the accompanying hieroglyphic legends make no allusion to the Egyptian deities. "Their features," observes Mr. Perring, from whom I derive these facts, "do not at all resemble the Egyptian; and, though much defaced, are evidently the same as those found on the propyla of Karnak, where we may recognise a similarity with the tall, white, slender, blue-eyed, and red-haired race, painted on the soles of the Egyptian sandals, and appearing also on the monuments, where they are emphatically called the *wicked race of Scheto.*"‡ One of these effigies is found only on fragments of stone which had pertained to temples antecedent to the eighteenth dynasty, which structures were overturned by the legitimate kings of that and the succeeding reigns, and

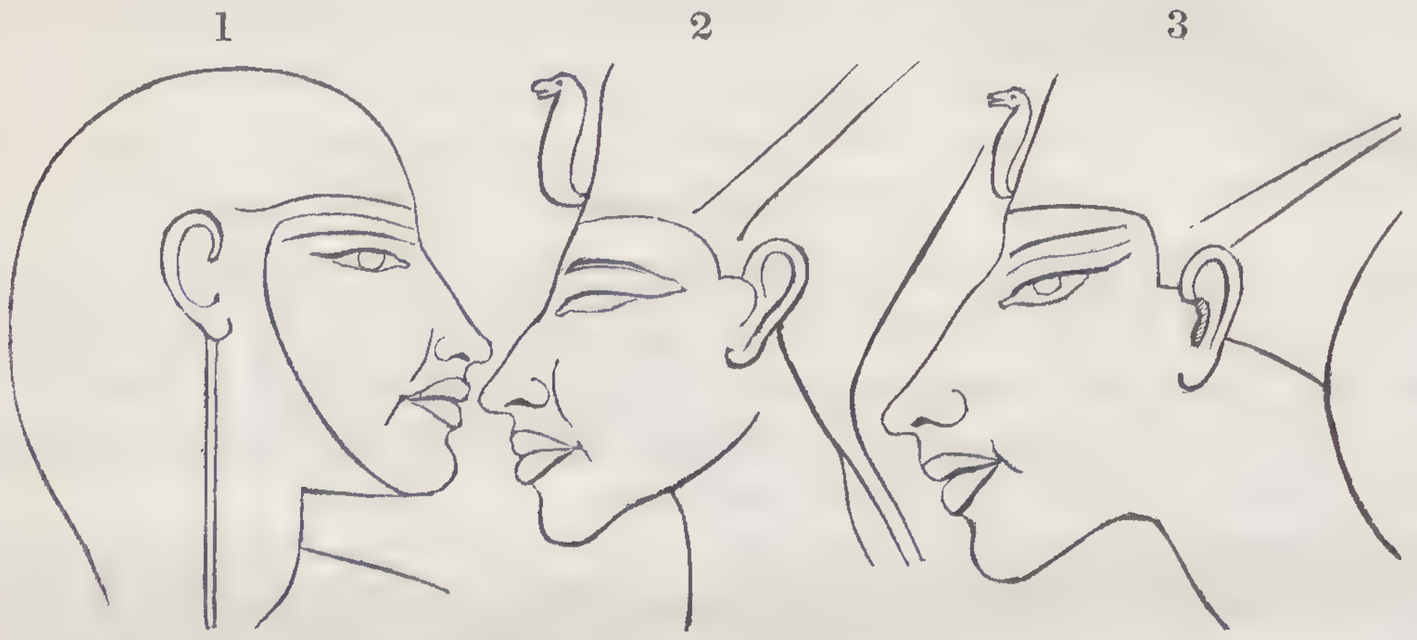
* The opinions of Sir G. Wilkinson are eminently entitled to respect on all Egyptian questions; and I need not apologize for quoting his opinions (however they may differ from those just given,) as briefly expressed in the following passage. "In manners, language, and many other respects, Egypt was certainly more Asiatic than African; and though there is no appearance of the Hindoo and Egyptian religions having been borrowed from one another, which many might be induced to conclude from their great analogy in some points, yet it is not improbable that these two nations may have proceeded from the same stock, and have migrated southward from their parent country in central Asia." —Ancient Egypt, Vol. I., p. 3.

† St. Augustine states that the Punic or Phenician tongue was in *his* day (the fifth century) a living language, and very like the Hebrew; and that the *Canaanitish* language was *mediate* between the Egyptian and the Hebrew. Mrs. H. Gray. Hist. of Etruria, p. 124.

‡ Transactions of the Royal Society of Literature, Vol. I., p. 140.

the *materials* used in erecting those splendid Pharaonic monuments of which they yet form a part.

The three following heads are copied from Mr. Perring's very interesting memoir.

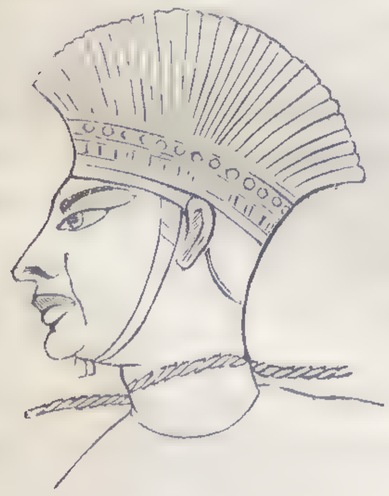


No. 1, the portrait of a king whose name is read *Skai* by Champollion, copied from his tomb in the western valley near Thebes. The bold, heavy features, and harsh expression are very remarkable, and Mr. Perring observes that this personage is represented of a much lighter red than is usual with the Egyptians.

No. 2. Head of another king of this exotic dynasty, with long sharp features, whose name reads *Atenre-Backhan* on the monuments, copied from a stone in the second propylon of Karnak.

No. 3. Another effigy of the same king, from the grottoes of El Tell, of which Mr. Perring remarks, that having been copied in haste it is somewhat in caricature.

El Tell, or Tel-el-Amarna, appears to have been the stronghold of these "foreign marauders," respecting whom Mr. Gliddon, after suggesting the probability that the sovereigns may have been of Arabian origin, inquires—"whether the present inhabitants, whose village occupies the once warlike camp or city of *Atenre*, have in their views and in their physical conformation, some vestiges of that early tribe of heterodox conquerors? And may not then the cause of the almost instinctive terror with which the natives of other parts of Egypt regard this vicinity, proceed from vague traditions of ancient predatory habits,—some fitful legend that has outlived thirty-five centuries?"*



There are many effigies of the same general character of the age of the fourth Rameses. One of them, a captive, is figured in the margin. Wilkinson reads their name Tochari on the monuments; Rosellini translates it Fekkaro. To my view they have the lined and hardy features of the Celts or Gauls, of whom, however, we have little knowledge at that remote date, (B. C. 1400,) although even then they occupied a large part of southern Europe. They perhaps rather pertain to the Phenician branch of the Caucasian race.

* Appeal to the Antiquarians of Europe on the destruction of the monuments of Egypt. By George R. Gliddon. p. 27. The portrait of Atenre-Backhan, another of these Hykshos kings, will be found in Wilkinson, second series, Plate XXX.

There are other paintings, especially some at Abousimbel of the age of Rameses III., which correspond in every particular with the Scythian physiognomy as recorded in history;* and the name of *Scheto*, by which they are designated on the monuments, confirms the suggestion of the hieroglyphists that they represent a Scythian or Scytho-Bactrian people.†

The researches of Lord Lindsay seem to prove that the Assyrians were also among the Hykshos conquerors of Egypt; and the shepherds who invaded Egypt before the time of Abraham are called *Cushim* by the ancients, which means Ethiopians or Babylonians; for the country on both sides of the Persian Gulf was called *Cush*.‡

Plutarch, quoting Manetho, asserts that Tiphonean or red-haired men were sacrificed in the temples of Eletheias, and their ashes scattered to the winds. Was this done in commemoration of the hatred which the Egyptians bore to the red-haired Hykshos?

6. THE COPTS.

From various antecedent remarks it will be perceived that I regard the Copts as a mixed community, derived in diverse proportions from the Caucasian and the Negro; and this diversity of origin may explain the dissimilar characteristics which travellers have ascribed to them.

Denon, for example, described them as having "flat foreheads, eyes half closed, and raised up at the angles, high cheek bones, a broad, flat, and short nose, a large, flattened mouth, placed at a considerable distance from the nose, thick lips, a little beard, a shapeless body, crooked legs, without expression in the contour, and long, flat toes."§ Denon even thinks that these features correspond, in a remarkable manner, with the human face and figure as represented in Egyptian painting and sculpture! And Sonnini, after describing them in nearly analogous terms, adds the moral reproach, that while "they are the ugliest of men, they are the filthiest and most disgusting."‖

If we compare these seemingly exaggerated descriptions with those of Brown, Lane, and some other travellers, the discrepancy is so great as, at first thought, to baffle all explanation. Brown, for example, "was not struck with any resemblance to the Negro features or form;" and he saw nothing remarkable in the texture of the hair.¶ "The eyes of the Copts," says Mr. Lane, "are generally large and elongated, slightly inclining from the nose upwards, and always black. The nose is straight, excepting at the end, where it is rounded and wide; and the lips are rather thick, and the hair is black and curly."** Madden adds that they are characterized by a remarkable distance between the eyes. Belzoni observed among them some as fair as Europeans; Rosellini assures us that they are largely mixed with Jewish and Roman blood;†† and D'Avezac, like Depauw, discovers in them a partial Chinese ancestry. These, and numberless other opi-

* Prichard, Researches, Vol. III., p. 441.
† Champollion, Monumens, Tom. I., Plate XXXVI.
‡ Mrs. H. Gray, History of Etruria, Vol. I., p. 31, 39.
§ Voyage en Egypte, I., p. 206.
‖ Trav. in Egypt, II., p. 168. See also Volney, Voyage, I., p. 70.
¶ Trav. in Africa, p. 77.
** Modern Egyptians, II., p. 310.
†† Monumenti, M. C. II., p. 77.

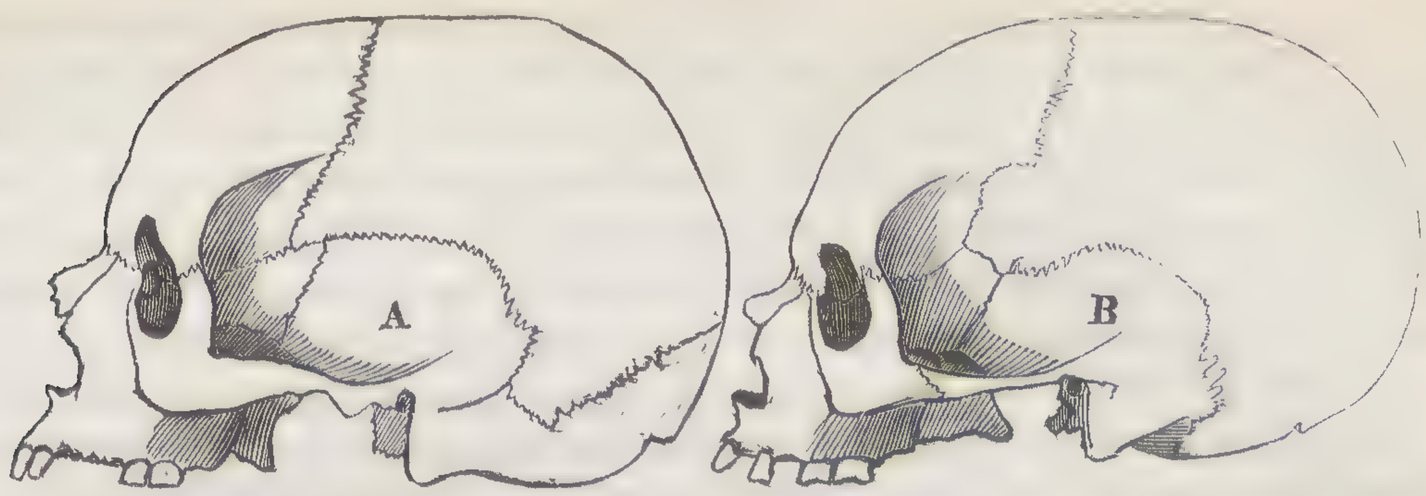
nions which might be cited, prove that the Copts differ greatly among themselves; and that they are, physically and morally, a mixture of all the nations which have successively held dominion in Egypt, or swelled its varied population—Egyptians of various castes, Greeks, Romans, Arabs, Hebrews, Negroes, and some others. Such was, at least in part, the opinion of Pugnet, (whose memoir I have not seen,) for he separates them "into two divisions; those whose ancestry has been intermixed, and partly of Greek and Latin descent, and a class of purely Egyptian origin."* But, after all, perhaps the traces which are most invariable in the Copt are derived from the Negro; and they are manifest in the very bones of the head and face.

"The inhabitants of the towns of Arabia and Egypt," says Burckhardt, "are in the daily habit of taking in wedlock Abyssinian as well as Negro slaves;"† and, in a subsequent part of his travels, the same intelligent author describes a class of people in Nubia who are the direct offspring of this mixture of race, and who seem, from his description, to answer the characters of the Copts themselves. "The Nouba slaves (among whom must be reckoned those who are born in Senaar of male Negroes and female Abyssinians) form a middle class between the blacks and the Abyssinians. Their features, though they retain evident signs of Negro origin, have still something of what is called regular; their noses, though smaller than those of Europeans, are less flat than those of Negroes; their lips are less thick, and the cheek bones less prominent. The hair of some is woolly; but among the greater part it is similar to the hair of Europeans, but *stronger*, and always curled." Another, and yet more striking example of the Negroid conformation is seen in the vast Foulah or Fellatah population of central Africa, which is now spread over a region of fifteen hundred miles from east to west, and five hundred miles from north to south. That they are a mixed progeny of Arabs, Berbers and Negroes, no longer admits of a reasonable doubt. Such is the opinion of D'Avezac and Hodgson, Vater, Adelung, and most other inquirers. "In the midst of the Negro races," observes M. D'Avezac, "there stands out a métive population, of tawny or copper colour, prominent nose, small mouth, and oval face, which ranks itself among the white races, and asserts itself to be descended from Arab fathers and Taurodo mothers. Their crisped hair, even woolly, though long, justifies their classification among the *Oulotric* (woolly-haired) populations; but neither the traits of their features, nor the colour of their skin, allow them to be confounded with Negroes, however great the fusion of the two types may be."‡ These and other facts derived from the slave trade, when considered in connexion with the Negro colonization of Nubia in the reign of Dioclesian, will account, I may repeat, not only for every blending of race observable in that country, but also assists us in tracing the origin of the Copts;—not to a *period* of time, it is true, but to circumstances which have been in operation for ages, and which were once, in all probability, far more active than they are at present.

By the kindness of Mr. Gliddon I possess three Coptic skulls, two of which are adult, and are accurately sketched in the subjoined drawings, (A and B.)

* Prichard, Researches, II., p. 238. † Trav. in Nubia, p. 217.

‡ For ample details of this interesting question, see D'Avezac, Esquisse générale de l'Afrique, p. 55; and Hodgson on the Foulahs of Central Africa, p. 5, *et passim.*



In A the cranium is elongated, narrow, but otherwise mediately developed in front, with great breadth and fulness in the whole posterior region. The nasal bones, though prominent, are broad, short, and concave, and the upper jaw is everted. There is, also, a remarkable distance between the eyes. The facial angle measures 81°, the internal capacity 85 cubic inches.

In the second head, B, the head is long and narrow, with a receding forehead, flat or concave nasal bones, and short, everted upper maxilla. Facial angle 78°; internal capacity 77 cubic inches.

A glance at these two crania will satisfy any one that they possess, in degree, both the conformation and expression of the Negro.

The third skull, that of a child of two years of age, corresponds in general form with the preceding, without having the African characteristics quite so obviously expressed.

It therefore follows, from all the evidence we possess in relation to the Copts, that, as a people, they partake sensibly, and sometimes largely, of Negro lineage.

An inspection of the royal portraits preserved in Rosellini, shows several heads which are obviously of the Coptic form; those, for example, of Sabbakon and Tirhaka, of the Ethiopian dynasty, and of the queen Metumva, of an earlier epoch. (Plate XIV.) The same lineaments, though in less degree, are also obvious in the effigies of Shishonk (Shishak) and Osorkon II., of the twenty-second dynasty, and in a few others of different periods of time. I wish it to be understood that I do not say these sovereigns were of Coptic lineage; but merely that their physiognomy, as expressed on the monuments, has the Coptic character. The history of the Copts remains an enigma in Egyptian ethnography.

7. THE NUBIANS.

It seems necessary, in further elucidation of this subject, to submit a few additional facts and observations in reference to the Berbers, or present inhabitants of Nubia, in order to show their relative position to the ancient occupants of that country. As the celebrated Burckhardt saw them in almost every locality, we shall mainly content ourselves with his graphic delineation. The Berbers, says he, are of a dark red-brown complexion, "which, if the mother is a slave from Abyssinia, becomes a light brown in the children; and if from the Negro countries, extremely dark. Their features are not at all those of the Negro, the face being oval, the nose often perfectly Grecian, and the cheek bones not prominent. The upper lip, however, is somewhat thicker than is considered beautiful among northern

nations, though it is still far from the Negro lip. Their hair is bushy and strong, but not woolly." The same intelligent traveller subsequently speaks of their language, respecting which he was certainly well qualified to judge: he assures us that the people south of Siout are ancient Bedouin tribes, who speak a very pure Arabic; and he makes a nearly similar remark respecting those who inhabit the river banks from Dongola to Senaar, and thence westward to Bornou, although they speak many different dialects.*

It is well known, however, that there are whole tribes in Nubia whose language is not derived from the Arabic; and these may be more nearly allied to the primitive population. "The inhabitants of Dar Dongola," says Dr. Rüppell, "are divided into two principal classes, namely, the Barábra, or *descendants of the old Ethiopian natives of the country*, and the races of Arabs who have emigrated from the Hedjar. The ancestors of the Berábra, who, in the course of centuries have been repeatedly conquered by hostile tribes, must have undergone some intermixture with people of foreign blood; yet an attentive inquiry will enable us to distinguish among them the old national physiognomy which their forefathers have marked upon colossal statues, and the bas-reliefs of temples and sepulchres. A long, oval countenance, a beautifully curved nose, somewhat rounded towards the tip, proportionately thick lips, but not protruding excessively, a retreating chin, scanty beard, lively eyes, strongly frizzled but never woolly hair, a remarkably beautiful figure, generally of middle size, and a bronze colour, are the characteristics of the genuine Dungolawi."† He adds, that the same traits of physiognomy are generally found among the Ababdé, the Bishareen, and partially among the people of Shendy and Abyssinia.

It must be acknowledged, however, that we can hardly expect to find the genuine Egypto-Ethiopian lineaments in any considerable number among the modern Nubians. Placed as the former were, between the Egyptians on the north, the Indo-Arabian nations on the east, and the Negroes on the south and west, and this, too, through the long period of several thousand years, their features must have become sensibly modified, even in the earliest times, by that blending of race which was inseparable from their position; and as the Koldagi and other Negro tribes have, at different times, established themselves in large bodies in Nubia, we need be at no loss, I conceive, in accounting for any traces of Negro lineage in some Barábra communities of the present day.

Dr. Prichard considers "the descent of the modern Nubians, or Berábra, from the Nouba (a Negro nation) of the hill country of Kordofan, to be as well established as very many facts which are regarded as certain by writers on ethnography." With every deference to that distinguished ethnographer, we may inquire, what became of the pre-existing inhabitants when the tribes of Kordofan colonized Nubia? Were they destroyed or expelled? History makes no mention of either; and we are justified in the opinion that an amalgamation of races took place, whence some of those diversities of organization observable in the modern Nubians. That this intermixture of races has continued to the present time, the reader will find abundant evidence in other parts of this memoir; yet I cannot here refrain from adding an observation from Cailliaud, who, remarking on the shortness of life among the people of Senaar from disease and dissipation, declares that the number of Negroes which pours into the country, and the fruitfulness of the women,

* Trav. in Nubia, p. 353.

† Prichard, Researches &c. vol. II. p. 174.

are the resources which serve to repair the vast and continual waste of population.* I may be told that this is proving too much. A sensible writer, and one who has ingeniously and instructively investigated the Nubian question, remarks as follows:—"The Arab tribes near Shendy may still, perhaps, justly boast of the purity of their blood; but, generally speaking, within the limits mentioned above, the slave or Negro population is about a sixth of the whole, and continually amalgamating with it. While nature kindly endeavours to wash out the stain, every caravan from the south or west pours in a new supply of slaves, and restores the blackening element."†

This author, however, in his desire to ascribe to climate the chief agency in the transformation of the Negro into the Nubian, seems to overlook the fact that while the Negroes flow into the country on the one side, the migratory Arabs invade it on the other, thus furnishing inexhaustible materials for the blending of the two races. I fully acquiesce, as before hinted, in the accuracy of the following opinion, as applied to a large proportion of the modern Nubians; namely, "that they are descended, not from the possessors of Ethiopia in its flourishing period, but from the prædial and slave population of the country, increased by colonists, and raised into a nation by peculiar circumstances between the third and sixth centuries of the Christian era."‡

8. THE NEGROES.

We have the most unequivocal evidence, historical and monumental, that slavery was among the earliest of the social institutions of Egypt, and that it was imposed on all conquered nations, white as well as black.§ So numerous was this unfortunate class of persons, that it was the boast of the Egyptian kings, recorded by Diodorus, that the vast structures of Luxor and Karnak were erected by the labour of foreigners alone. Of Negro slavery, in particular, the paintings and sculptures give abundant illustration. "Black people," says Sir G. Wilkinson, "designated as natives of the *foreign land* of Cush, are generally represented on the Egyptian monuments as captives or bearers of tribute to the Pharaohs;" and the attendant circumstances of this inhuman traffic appear to have been much the same in ancient as in modern times. It is curious, also, in a numerical point of view, to observe that Arrian, who wrote in the second century, gives three thousand as the number of Negroes annually brought down the Nile in his time; while Madden, writing in our own day, and consequently sixteen hundred years later than Arrian, esti-

* Voyage à Meroë, II., p. 276. † Edinburgh Review, Vol. LX., p. 311.

‡ Idem., p. 307. The antiquity of the name Nubia, is of some importance in this discussion. Heeren and others state that it first occurs in history during the epoch of the Ptolemies; but Rosellini has now discovered that it is at least as old as the age of Meneptha I., (B. C. 1600,) on whose monuments it is found.

Since the above note was written, Mr. Gliddon has obligingly furnished me with the following interesting memorandum: "The name Nubia, with its derivatives of Nouba and Noubatæ, may be readily traced to *Noubnoub*, a Nubian divinity in the hieroglyphical legends of Meneptha I. and Rameses II. and III., and may possibly be derived from the root *noub*, gold, from the proximity of Nubia to the Ethiopian gold countries. The word *Berber*, as applied to the people of Nubia, (now called Berabera in the plural, from Berberri, the singular,) is without question derived from the hieroglyphical name *Barobaro*, by which at least one tribe inhabiting Nubia was known to the Egyptians of the 18th dynasty."

§ Sir G. Wilkinson observes that "no difficulty occurred to the Ishmaelites in the purchase of Joseph from his brethren, nor on his subsequent sale to Potiphar on arriving in Egypt." Ancient Egyptians, I., p. 404.

mates the present number in nearly the same words. If it be allowable to make these data the basis of calculation for the past thirty-five centuries, it will follow that upwards of ten millions of Negroes have been brought as bondsmen into Egypt during that period. This I regard a reasonable calculation; for in the present wasted and depopulated condition of the country, the demand for servants and slaves must be far below what it was in the flourishing epoch of the Pharaohs.*

This vast influx of Negroes into the valley of the Nile must necessarily have left its impression on the physical traits of the Egyptians themselves; in modern times, as seen in the Copts, and in more distant periods, as proved by the Negroid heads, in which both the configuration and expression are too obvious to be mistaken. But it may be inquired, how does it happen that Negroes or their descendants should be found in the catacombs, if they constituted a menial or slave-caste in Egypt? In reply, it may be observed that persons of this race have been capable, in all ages, of elevating themselves to posts of distinction in the east, and especially and proverbially those who have belonged to the class of eunuchs.† It is also important to observe, that so tenacious were the Egyptians of the rights of their offspring, that they admitted them to equal privileges with themselves, *even when the mother was a slave;* and these usages extended to inheritance.‡

The preceding facts, without multiplying more on the same subject, amply account for that interminable amalgamation of the Caucasian and Negro races which has been going on in Egypt from the remotest times; while they also explain that incidental social elevation of the Negro caste, to which the monuments and catacombs alike bear witness.

This blending of races is farther illustrated in the present population of Nubia. The traveller Burckhardt remarks, that the slaves sent down the Nile, and those transported to Arabia, bear but a small proportion to the number kept by the Mahommedans of the more southern countries of Africa. At Shendy, for example, from one to six are seen in every family; and the custom prevails as far as Senaar, and westward to Kordofan, Darfour and Bornou. All the Bedouin tribes who inhabit or surround these countries are well stocked with slaves, nor does the number diminish in the very remote provinces of Houssa and Begarmeh; and we are told by the same intelligent observer, that the result of this promiscuous intercourse is a mixed progeny, which blends the characteristics of the Arab with those of the Negro.§

Negroes are abundantly represented on the pictorial delineations of the Egyptian monuments of every epoch. Complexion, features, and expression, these and every other attribute of the race, are depicted precisely as we are accustomed to see them in our daily walks: indeed, were we to judge by the drawings alone, we might suppose them to have

* Clot Bey states the present black population of Egypt to be twenty thousand; and he adds that Negresses form the greater number of women in almost every harem. Aperçu Générale de l'Egypte, I., p. 329.

† A passage in Manetho establishes at the same time the antiquity and the power of eunuchs in Egypt; for he relates that king Ammenemes, of the twelfth dynasty, was slain by them. This event will date, by the received chronology, upwards of twenty-two hundred years B. C. Cory, Frag., p. 110. Eunuchs appear, also, to be figured on the monuments. Vide Rosellini, M. C. III., p. 133.

‡ Wilkinson, Ancient Egyptians, II., p. 64.

§ Notwithstanding this mixture of nations, Mr. Hoskins observes, that the higher classes of modern Ethiopians (Nubians,) pay great respect to the distinctions of race; that they esteem nothing more than a light complexion, which the petty kings or chiefs make a prerequisite to the selection of wives; and that, with this class, "all mixture with the Negro blood is carefully shunned."—Travels in Ethiopia, p. 357.

been executed but yesterday; and yet some of these vivid delineations are nearly three thousand five hundred years old! and, moreover, as if to enforce the distinction of race by direct contrast, they are placed side by side with people of the purest Caucasian features.

The delineations of the Negro which are supposed to be of the most ancient date have not yet been identified with the epoch to which they belong. Such are those in a tomb at Thebes of the age of Amontuonch, an "unplaced king," who is supposed to date prior to the sixteenth dynasty, and consequently more than two thousand years before Christ.* There is, however, a difference of opinion on this point; but we can refer with confidence and certainty to the celebrated "Procession" of the age of Thotmes the Fourth, at Thebes, in which Negroes are represented as tribute-bearers to that monarch at a period which dates about seventeen hundred years before our era.†

Sir G. Wilkinson describes a painting in a catacomb at Thebes of the age of Amunoph the Third, in which that personage, seated on his throne, receives the homage and tribute of various nations. Among these are represented several "black chiefs of Cush, or Ethiopia," whose presents consist of rings of gold, bags of precious stones, "a camelopard, panthers, skins, and long-horned cattle, whose heads are strangely ornamented with the hands and heads of Negroes."‡ The author justly adds, that the latter effigies were probably artificial; for the people of Cush would scarcely have decapitated their own people to adorn their offerings to a foreign prince: yet at the same time these melancholy symbols were obviously designed to express the most abject self-abasement and vassalage.

Other Negro delineations which can be identified with the age to which they belong, are found on the monuments of Horus, Rameses the Second, Rameses the Third, &c. in various places in Egypt and Nubia; and the first of these kings, (who dates with the nineteenth dynasty,) is represented standing on a platform which is supported by prostrate Negroes.§

For the purpose of illustration, we select a single picture from the temple (hemispeos) of Beyt-el-Wàlee, in Nubia, in which Rameses the Second is represented in the act of making war upon the Negroes; who, overcome with defeat, are flying in consternation before him. From the multitude of fugitives in this scene, (which has been vividly copied by Champollion‖ and Rosellini, and which I have compared in both,) I annex a fac-simile group of nine heads, which, while they preserve the national features in a remarkable degree, present also considerable diversity of expression.

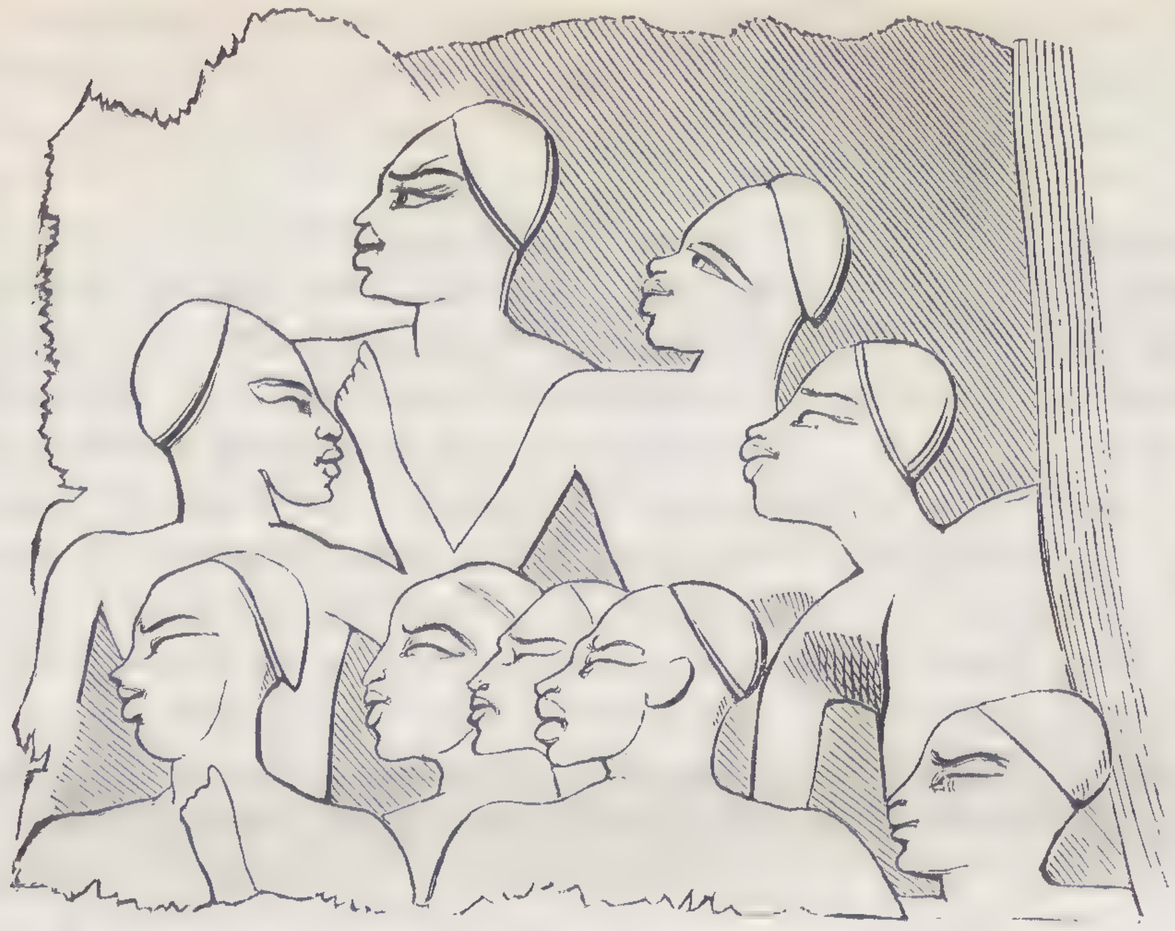
* Rosellini, Appendix, No. 13.—Wilkinson, Ancient Egyptians, Vol. III.

† Hoskins, Travels in Ethiopia. Procession, Part First.

‡ Topography of Thebes, p. 136.

§ Champollion, Monumens de l'Egypte, Plate CX.

‖ Vide Champollion, Monumens de l'Egypte, Tom. I., Plate LXXI., LXXII.; and Rosellini, Monumenti, M. R., Tav. LXXV. A glance at these illustrations will convince any one that the slave-hunts or *ghrazzies*, as now practised by the Arabs, Tuaricks and Turks, and which are so feelingly described by Cailliaud, and by Denham and Clapperton, were in active operation, with all their atrocities, in the most flourishing periods of Pharaonic Egypt.



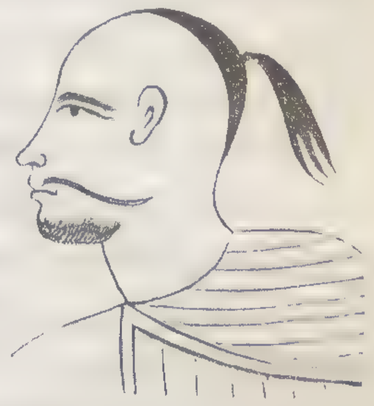
The hair on some other figures of this group is dressed in short and separate tufts, or inverted cones, precisely like those now worn by the Negroes of Madagascar, as figured in Botteller's voyage.

In the midst of the vanquished Africans, seated in his car and urging on the conflict, is Rameses himself; whose manly and beautiful countenance will not suffer by comparison with the finest Caucasian models. The annexed outline, (for all the figures are represented in outline only,) will enable the reader to form his own conclusions respecting this extraordinary group, which is believed to date about fifteen hundred and seventy years before the Christian era.

9. THE MONGOLIANS.

It has been contended by Depauw, and others that the ancient Egyptians were of the Mongolian race. I find nothing like Mongolian features in any embalmed head in my collection, unless some general resemblance can be traced in a solitary instance from Thebes, (Plate XII., Figs. 1, 2,) which, however, partakes more obviously of the Semitic form. This observation sustains the opinion of Professor Blumenbach, who in comparing the Egyptians with the several races of men, asserts, that "they differ from none more than from the Mongolian, to which the Chinese belong."*

That the Chinese had commercial intercourse with the Egyptians in very early times, is beyond question; for vessels of Chinese porcelain, with inscriptions in that language, have been repeatedly found in the Theban catacombs.† Yet in every instance wherein we detect Mongolians on the monuments, they are represented as foreigners and enemies. The annexed wood-cut, with the small and somewhat depressed nose, shaven head, and crown-lock, scanty beard, moustache, and sallow complexion, seems clearly to indicate a man of that race. It is copied from a drawing in Rosellini, in which Rameses the Third is represented fighting against the *Sheto* or Scythians, among whom the Mongols appear to be allies or mercenaries.



REMARKS.

Since the physical characteristics of the ancient Nilotic population, as derived from history and the monuments, coincide in a remarkable manner with the facts derived from anatomical comparison, it becomes in the next place necessary to offer some explanation of these results; or, to show at what periods and under what circumstances several different branches of the Caucasian race were blended into a single nation possessing more or less the characteristics of each, and this again modified in degree by another race wholly different from either. It is in the first place necessary to recur to the fact of the very long occupation of Egypt by successive dynasties of Hykshos or shepherd kings, and that these were not of one but of several nations—Phenicians, Pelasgi, and Scythians; while to these followed, at a long interval, an Ethiopian or Austral-Egyptian dynasty. Each of these great revolutions must have tended in turn to the amalgamation of the Egyptians with other nations; and this result may be referred to three principal epochs, independently of several subordinate ones.

THE FIRST EPOCH embraces the dynasty of the Hykshos or shepherd kings, commencing before Christ two thousand and eighty, and having a duration of two hundred and sixty years.

It is important, however, to observe, that Josephus quoting Manetho, makes the Hykshos dynasty last five hundred and eleven years; and the learned Baron Bunsen, whose work has not yet appeared, extends it to 1000, beginning B. C. 2514.‡ The shorter

* Transactions of the Royal Society of London, 1794, p. 193.
† Wilkinson's Ancient Egyptians, Vol. III. p. 108.
‡ See Mrs. Hamilton Gray's History of Etruria, Vol. I., p. 29.

period is that of Rosellini; but the longer one is perhaps most consistent with facts, and at least makes room for those various dominations which, in the lists of Manetho, precede the eighteenth dynasty; which last, headed by Amunoph the First, drove out the intrusive kings. During this long period the legitimate sovereigns were exiled into Ethiopia; and it is evident, that had Meroë been any other than a province or dependency of Egypt, it is hardly probable that the Egyptians,—kings, priests, and people,—could have found a safe asylum in that country during the long period of their exile. It is expressly stated by Josephus that the shepherd kings lived at Memphis, "and made both the upper and lower country pay tribute." It would appear, however, that during the greater part of the Hykshos dynasty, the Egyptians retained possession of the Thebaid: nevertheless the occupation of Lower Egypt by their enemies, must have effectually precluded all communication with other countries excepting Ethiopia, southern Arabia and India; which fact will account for a vast influx of population from those countries, (and consequently from the slave-regions of Africa) into the Upper Nilotic provinces.

It is moreover reasonable to suppose that even after the expulsion of the Hykshos, multitudes of Egyptians would remain in Ethiopia,—that country wherein whole generations of their ancestors had lived and died; at the same time that great numbers of Meröites, influenced by a variety of motives and especially by social alliances, would descend the Nile into Egypt.

It is moreover evident that while the Egyptians became thus fraternized with the nations of southern Asia, and the motley races of the Upper Nile, the provinces of Lower Egypt would be overrun with the Caucasian tribes of Europe and western Asia; for these, either as cognate with the Hykshos or as allies in their service, must have been in immense number to have conquered so populous a country, and especially to have kept possession during so long a period. It is to these events, then, that we attribute that blending of nations which appears to have been coeval with the early ages of the Nilotic Family, and which amply accounts for the ethnographic diversities every where manifest on the monuments.

THE SECOND EPOCH is comprised in the Ethiopian Dynasty of three kings, which lasted forty-four years, beginning B. C. 719.

These Meröite or Austral-Egyptian kings, during their intrusive occupation of Egypt, would naturally, and indeed necessarily engage the neighbouring tribes, and especially such as were hostile to Egypt, as mercenary soldiers; and there are more than conjectural grounds for believing that the Negroes themselves were thus employed. We are told in the Sacred Writings (2 Chron. Chap. xii.) that when Shishak king of Egypt, who is identical with Sheshonk of the monuments,—went up against Jerusalem, he took with him "1200 chariots, and three-score thousand horsemen: and the people were without number that came with him out of Egypt; the Lubims, the Sukkiims and the Ethiopians." Of this multitude we may presume that the horsemen, and people in chariots were part of the Egyptian army; the Lubims and Sukkiims are by most commentators regarded as Libyans and Meröites, while, as the Ethiopians are placed last on the list, and are designated in the Hebrew original by the name of *Cush*, it is not unreasonable to suppose that they were Negroes. This view is sustained by a passage in Herodotus,* who states that

* In my *Crania Americana*, Note p. 29, I have employed this passage to show, that those *Colchians* whom Herodotus mentions as forming "part of the troops of Sesostris," might have been Negroes acting as mercenary or auxiliary sol-

in the army of Xerxes which invaded Greece was a legion of *Western Ethiopians*, "who had hair more crisp and curling than any other men."* Now if the army of Xerxes embraced a legion of African Negroes, it would not be remarkable if the Egyptian troops should have been composed in part of the same people; which, indeed, with respect to the Ethiopian dynasty, may be assumed as a thing of course: for the Meröites would naturally avail themselves of every expedient to establish their power by augmenting the number of their exotic confederates, and by extending to them those privileges which had once been sacred to particular castes. For these and other oppressive acts, the Meröite kings were hated by the Egyptians; and no sooner were they expelled than their names were erased from the monuments.†

THE THIRD EPOCH dates from the conquest by Cambyses, B. C. 525, and continues through the whole of the Persian dynasty, or, in other words, until the Ptolemaic era, B. C. 332,—a period of nearly two hundred years.

Every one knows that the Persian dominion in Egypt was marked by an utter disregard of all the established institutions. No occasion was omitted which could humble the pride or debase the character of the people. The varied inhabitants of Europe, Asia and Nigritia poured into the valley of the Nile, abolishing in degree the exclusiveness of caste, and involving an endless confusion of races.

The prelude to these changes and misfortunes can be traced to the reign of Psammeticus the First, who permitted to foreigners, and especially to the Greeks, a freedom of ingress which the laws and usages of the country had previously denied them. The same policy appears to have been fostered by the subsequent kings of the same dynasty, until its consummation by Amasis; (B. C. 569) when, in the language of Champollion Figéac, Egypt became at once Egyptian, Greek, and Asiatic; her national character was lost for ever; her armies were filled with foreign mercenaries; the throne was guarded by European soldiers, and continual wars completed the destruction of a tottering kingdom.‡

CONCLUSIONS.

1. The valley of the Nile, both in Egypt and in Nubia, was originally peopled by a branch of the Caucasian race.

2. These primeval people, since called Egyptians, were the Mizraimites of Scripture, the posterity of Ham, and directly affiliated with the Libyan family of nations.

3. In their physical character the Egyptians were intermediate between the Indo-European and Semitic races.

diers. I am now satisfied that such explanation is at least unnecessary, and I, therefore, take this occasion to withdraw it.

* Polhym. Cap. lxx.

† Among the meager facts which history has preserved in relation to these intrusive kings, the following is the most remarkable: "Sabakon (the first king of the Ethiopian dynasty) having taken Boccoris (the legitimate sovereign) captive, burnt him alive." Manetho *apud* Cory, Frag. p. 126. Could any circumstance have rendered the Ethiopians more detestable in the eyes of the Egyptians than this first act of barbarian policy?

‡ Egypte Ancienne, p. 207.

4. The Austral-Egyptian or Meröite communities were an Indo-Arabian stock engrafted on the primitive Libyan inhabitants.

5. Besides these exotic sources of population, the Egyptian race was at different periods modified by the influx of the Caucasian nations of Asia and Europe,—Pelasgi, or Hellenes, Scythians and Phenicians.

6. Kings of Egypt appear to have been incidentally derived from each of the above nations.

7. The Copts, in part at least, are a mixture of the Caucasian and the Negro in extremely variable proportions.

8. Negroes were numerous in Egypt, but their social position in ancient times was the same that it now is, that of servants and slaves.

9. The national characteristics of all these families of Man are distinctly figured on the monuments; and all of them, excepting the Scythians and Phenicians, have been identified in the catacombs.

10. The present Fellahs are the lineal and least mixed descendants of the ancient Egyptians; and the latter are collaterally represented by the Tuaricks, Kabyles, Siwahs, and other remains of the Libyan family of nations.

11. The modern Nubians, with a few exceptions, are not the descendants of the monumental Ethiopians, but a variously mixed race of Arabs and Negroes.

12. Whatever may have been the size of the *cartilaginous* portion of the ear, the osseous structure conforms in every instance to the usual relative position.

13. The Teeth, differ in nothing from those of other Caucasian nations.

14. The Hair of the Egyptians resembled, in texture, that of the fairest Europeans of the present day.

15. The physical or organic characters which distinguish the several races of men, are as old as the oldest records of our species.

Note.—I have taken frequent occasion to quote the opinions of the late Professor Blumenbach, of Göttingen, whose name is inseparably connected with the science of Ethnography; but I have to regret that up to the present time I have not been able to procure either in this country or from Europe, the last two memoirs which embrace his views on Egyptian subjects, and especially the work entitled, "Specimen historiæ naturalis antique artis operibus illustratæ." His views, however, as previously given to the world, have been repeatedly adverted to in these pages; and his matured and latest observations, as quoted by Dr. Wiseman, appear to have confirmed his original sentiments. "In 1808," says Dr. Wiseman, "he more clearly expressed his opinion that the monuments prove the existence of *three distinct forms* or physiognomies among the ancient inhabitants of Egypt. Three years later he entered more fully into this inquiry, and gave the monuments, which he thought bore him out in this hypothesis. The first of these *forms* he considers to approach to the Negro model, the second to the Hindoo, the third to the Berber, or ordinary Egyptian head. (*Beträge zur Naturgeschichte*, 2 *ter Th.* 1811.) But I think an unprejudiced observer will not easily follow him so far. The first head has nothing in common with the *Black race*, but is only a coarser representation of the Egyptian type; the second is only its mythological or ideal purification." *Lectures on the Connexion between Science and Revealed Religion*, 2*d edit. p.* 100.

I thus place side by side the opinions of these learned men. With respect to Professor Blumenbach, I may add that when he wrote on Egyptian ethnography there were no *fac simile* copies of the monuments, such as have since been given to the world by the French and Tuscan Commissions; and again, that learned author had not access to a sufficient number of embalmed heads to enable him to compare these with the monumental effigies. With these lights he would at once have detected *an all-pervading physiognomy which is peculiarly and essentially* Egyptian; and in respect to which all the other forms,—Pelasgic, Semitic, Hindu and Negro are incidental and subordinate; sometimes, it is true, represented with the attributes of royalty, but for the most part depicted as foreigners, enemies and bondsmen.

With Egyptian *statuary* I am little acquainted. The only four years of my life which were spent in Europe were devoted almost exclusively to professional pursuits; and the many remains of Egyptian art which are preserved in the British and continental museums, have left but a vague impression on my memory. How invaluable to Ethnography are the two statues of the First Osortasen, now in the royal cabinet of Berlin! These I have not seen, nor the memoir in which Dr. Lepsius has described them.

I have, for the most part, omitted any remarks on the intellectual and moral character of the Egyptians, because they would have extended my work beyond the limits prescribed by the present mode of publication. I have also avoided, as much as possible, those philological disquisitions which have of late years combined so much interest and discrepancy, but which are all-important to Egyptian ethnography, and are daily becoming better understood, and therefore of more practical value. For an instructive view of this question, and many collateral facts and opinions, the reader is referred to the third volume of Dr. Prichard's *Researches into the Physical History of Mankind;* a work which commands our unqualified admiration both in respect to the multitude and the accuracy of the facts it contains, and the genius and learning with which they are woven together.

I look with great interest to the researches of Dr. Lepsius at Meroë; as well as to those of my friend Dr. Charles Pickering, who is now in Egypt for the sole purpose of studying the monuments in connexion with the people of that country. And finally, it gives me great pleasure to state that the profound erudition of the Baron Alexander de Humboldt is at this moment engaged in a work which will embrace his views on Egyptian ethnography, and give to the world the matured opinions of a mind which has already illuminated every department of natural science.

ARTICLE IV.

On two Storms which were experienced throughout the United States, in the month of February, 1842. *By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. Read May* 26, 1843.

The favour with which my account of the storm of December 20, 1836, has been received, has induced me again to undertake a similar investigation. A remarkable tornado was experienced in the north-east part of Ohio, February 4, 1842, an account of which may be found in the American Journal of Science, Volume xliii., pages 278—300. I was induced to hope that a careful investigation of the phenomena of the general storm which accompanied the tornado, might throw some light upon the origin of the tornado itself. Hence this storm was selected for investigation. Another very remarkable storm having been experienced about the middle of the same month, it occurred to me that I might obtain the materials for an investigation of both storms with about the same ease as for one. In collecting these materials, I have to acknowledge my obligations to my correspondents. To Professor Bache, I am indebted for a copy of the observations made in the State of Pennsylvania. To Professor Espy, I am indebted for a large mass of information he has, with great pains, collected, and which he has generously placed at my disposal. The remaining observations were chiefly obtained by direct application to the observers. I have thus obtained sixty-eight registers, containing barometric observations. The situation of the stations, and the authority upon which the observations rest, are shown in the following table.

STATION.	LATITUDE.	LONG.	AUTHORITY.
Natchez, Mississippi,	31° 34′ N.	91°25′	Dr. Henry Tooley.
Vicksburgh, Mississippi,	32 24	91 6	N. W. Hatch.
Bloomington, Iowa,	41 26	91 2	T. S. Parvin.
New Orleans, Louisiana,	29 58	90 7	D. T. Lillie.
St. Louis, Missouri,	38 36	89 36	Dr. B. B. Brown.
Mobile, Alabama,	30 42	87 59	Dr. Stephen B. North.
Pensacola, Florida,	30 28	87 12	Isaac Hulse.
Nashville, Tennessee,	36 10	86 49	Professor James Hamilton.
Louisville, Kentucky,	38 3	85 30	Thomas S. Caldwell.
Cincinnati, Ohio,	39 6	84 27	Professor Joseph Ray.
" "	39 6	84 27	M. G. Williams.
Athens, Georgia,	33 59	83 32	Professor C. F. M'Coy.
Portsmouth, Ohio,	38 48	83 3	Dr. S. B. Hempstead.

STATION.	LATITUDE.	LONG.	AUTHORITY.
Detroit, Michigan,	42°24′ N.	82°58′	Rev. George Duffield.
Chillicothe, Ohio,	39 21	82 55	Dr. E. H. Davis.
Marietta, Ohio,	39 25	81 26	Dr. S. P. Hildreth.
Hudson, Ohio,	41 15	81 27	Professor Elias Loomis.
Savannah, Georgia,	32 5	81 7	Dr. John F. Posey.
Meadville, Pennsylvania,	41 39	80 16	Henry Shippen.
Erie, Pennsylvania,	42 7	80 12	James C. Reid.
Pittsburgh, Pennsylvania,	40 32	80 2	J. P. Bakewell.
Butler, Pennsylvania,	40 52	79 58	Jacob Mechling.
Charleston, South Carolina,	32 47	79 57	Robert Lebby.
Franklin, Pennsylvania,	41 24	79 55	William Connelly.
Uniontown, Pennsylvania,	39 54	79 48	President J. P. Wecther.
Toronto, Canada,	43 33	79 20	Magnetic Observatory.
Somerset, Pennsylvania,	40 0	79 6	George Mowry.
Ebensburgh, Pennsylvania,	40 31	78 46	Richard Lewis.
Bedford, Pennsylvania,	40 1	78 29	Samuel Brown.
Millville, New York,	43 8	78 20	James F. Cogswell.
Huntingdon, Pennsylvania,	40 32	78 1	Professor Jacob Miller.
Rochester, New York,	43 8	77 51	Rev. Chester Dewey.
Nassau, Bahamas,	25 16	77 48	Honourable John C. Lees.
Bellefonte, Pennsylvania,	40 55	77 48	John Harris.
Mifflintown, Pennsylvania,	40 34	77 24	J. A. Kinkead.
Gettysburgh, Pennsylvania,	39 49	77 11	Professor M. Jacobs.
Carlisle, Pennsylvania,	40 13	77 10	Professor W. H. Allen.
Washington, Dist. of Columbia,	38 53	77 1	Lieutenant Gilliss.
Harrisburgh, Pennsylvania,	40 16	76 50	J. Heiseby.
Northumberland, Pennsylvania,	40 53	76 50	Andrew C. Huston.
Lancaster, Pennsylvania,	40 3	76 21	Conservatory of Arts.
Gosport, Virginia,	36 51	76 19	William F. Patton.
Port Carbon, Pennsylvania,	40 45	76 7	P. C. Lyceum.
Casenovia, New York,	42 55	75 46	H. R. Clark.
West Chester, Pennsylvania,	39 57	75 30	E. W. Beans.
Haverford, Pennsylvania,	40 1	75 19	Haverford School.
Philadelphia, Pennsylvania,	39 57	75 10	Owen Evans.
" "	39 57	75 10	John Conrad.
Newtown, Pennsylvania,	40 14	74 49	L. H. Parsons.
New York City,	40 43	74 1	William C. Redfield.
" "	40 43	74 1	Professor B. F. Jortin.
" "	40 43	74 1	B. Ticknor.
North Salem, New York,	41 22	73 44	John F. Jenkins.
Montreal, Canada,	45 31	73 35	John S. M'Cord.
Williamstown, Massachusetts,	42 43	73 13	G. F. Bigelow.
New Haven, Connecticut,	41 18	72 58	Connecticut Academy.
Amherst, Massachusetts,	42 22	72 32	Professor E. S. Snell.
Hanover, New Hampshire,	43 41	72 22	Professor Ira Young.
Worcester, Massachusetts,	42 16	71 48	Lunatic Hospital.
Providence, Rhode Island,	41 49	71 25	Professor Alexis Caswell.
Cambridge, Massachusetts,	42 22	71 8	William C. Bond.
New Bedford, Massachusetts,	41 38	70 56	S. Rodman.
Portsmouth, New Hampshire,	43 5	70 46	Charles Chase.
Nantucket, Massachusetts,	41 17	70 6	William Mitchell.
Gardiner, Maine,	44 10	69 50	R. H. Gardiner.
Waterville, Maine,	44 35	69 41	Professor George W. Kesly.
Bermuda Islands,	32 34	63 28	Thomas Phillips.
St. John's, New Foundland,	47 34	52 38	Joseph Templeman.

I have obtained observations from the following military posts, but they give no record of the barometer.

POSTS.	LATITUDE.	LONG.	POSTS.	LATITUDE.	LONG.
Fort Gibson, Arkansas,	35°47′N.	95°19′	Augusta Arsenal, Georgia,	33°27′N.	81°33′
Fort Leavenworth, Missouri,	39 28	95 14	Alleghany Arsenal,	40 28	80 7
Fort Towson, Arkansas,	33 36	95 4	Fort Niagara,	43 14	79 7
Fort Smith, Arkansas,	35 20	94 21	Buffalo Barracks, New York,	42 53	78 55
Fort Wayne, Arkansas,			Carlisle Barracks, Pennsylvania,	40 12	77 10
Fort Jesup, Louisiana,	31 35	93 42	Fort M'Henry, Maryland,	39 18	76 35
Fort Snelling, Iowa,	44 53	93 12	Fort Monroe, Virginia,	36 50	76 22
Fort Atkinson, Iòwa,	43 0	92 1	Madison Barracks, New York,	43 45	76 1
Fort Crawford, Wiskonsin,	43 4	91 7	Fort Columbus, New York,	40 41	74 1
Jefferson Barracks, Missouri,	38 32	90 25	Fort Wood, New York,	40 42	74 1
St. Louis Arsenal, Missouri,	38 37	90 21	West Point, New York,	41 25	74 0
New Orleans Barracks,	29 57	90 9	Watervliet Arsenal, New York,	42 45	73 45
Fort Winnebago, Wiskonsin,	43 32	88 53	Plattsburgh, New York,	44 42	73 32
Fort Mackinac, Michigan,	45 46	84 40	Fort Adam, Rhode Island,	41 20	71 19
Fort Brady, Michigan,	46 29	84 18	Fort Constitution, New Hamp-	43 4	70 45
Fort Robert Gamble,	30 25	83 31	shire,		
Dearbornville Arsenal, Michigan,	42 24	83 2	Fort Preble, Maine,	43 39	70 20
Detroit, Michigan,	42 24	82 58	Fort Kent, Maine,	47 15	68 46
Fort Gilmer, Georgia,	30 40	82 52	Fort Fairfield, Maine,	46 50	68 0
Fort Gratiot, Michigan,	42 54	82 25	Hancock Barracks, Maine,	46 8	67 51
Fort Henderson, Georgia,	30 45	82 10	Fort Sullivan, Maine,	44 54	66 56

I have also received observations from eighteen posts in Florida, but have made little use of them. I have received observations of the thermometer, etc., but not of the barometer, from the following places.

STATION.	LATITUDE.	LONG.	AUTHORITY.
Mount Atlas, Carroll Co., Tenn.,	36° 0′	88°30′N.	Dr. John Travis.
Carmi, Illinois,	38 5	88 13	W. H. Sorgenfrey.
Indianapolis, Indiana,	39 55	86 5	John Wheeler.
Washington, Michigan,	42 43	82 56	Dennis Cooley.
St. Mary's, Georgia,	30 44	81 46	S. R. Williams.
Ravenna, Ohio,	41 10	81 13	Newton Peck.
Lockport, New York,	43 11	78 46	Edward Giddins.
Gaines, New York,	43 16	78 26	M. Mason, M.D.
Winchester, Virginia,	39 11	78 13	Anonymous.
Williamsburgh, Virginia,	37 16	76 40	Alexander D. Galt.
Sacketts Harbour, New York,	43 55	75 57	Zeno Allen.
Utica, New York,	43 7	75 13	S. Aylesworth.
Clermont Academy, near Frank-			
ford, Pennsylvania,	40 0	74 55	Samuel S. Griscom.
Trenton, New Jersey,	40 14	74 30	Francis A. Ewing.
Malone, New York,	44 51	74 15	E. N. Winslow.
Albany, New York,	42 39	73 45	Dr. Phillips Ten Eyck.
Middleton, Connecticut,	41 33	72 39	Joseph Barrett, M.D.
Grafton, Vermont,	43 11	72 35	A. Putnam.
Newport, Rhode Island,	41 29	71 19	R. J. Taylor.
Portland, Maine,	43 39	70 20	Samuel Moody.
Charleston, Maine,	45 5	69 0	E. M. Thurston.
Eastport, Maine,	44 54	66 56	S. B. Mitchell.

Some memoranda of the weather, but without observations either of the barometer or thermometer, have been received from several other stations. As I intend this paper for a continuation of my former investigations, I shall dispense with a good deal of preliminary explanation which might otherwise seem called for.

Storm of February 16, 1842.

I have represented the principal phenomena of this storm on the accompanying charts, one to five. Those regions, where the sky was unclouded, or where the cloudiness was less than one half, are coloured blue; those where the sky was entirely overcast, or the cloudiness exceeded one half, but without rain or snow, are coloured brown; the fall of snow is indicated by the green colour, and rain by the yellow. The direction of the wind is represented by the arrows, and its force is, to a certain extent, indicated by their length. When, however, the winds were faint, the arrows, if drawn of a strictly proportionate length, would have been too short to attract notice, and are therefore somewhat magnified. A calm is represented by a cipher, (0). I have also represented the barometric, and thermometric observations in the following manner: Having determined, as well as I was able, the mean height of the barometer at each station, I compared each observation with the mean. I then drew a line passing through all the places, where the barometer stands at its mean height. This line is marked — — 0, and may be called the line of mean pressure. I then drew a line through all the places where the barometer stands two inches above the mean. This line is marked — — — + .2, and so of the others. In like manner, a line joining all those places where the thermometer stands at its mean height for that hour and month, is marked . . . . . 0°, and may be called the line of mean temperature. Another line joins all those places where the thermometer is 10° above the mean, and is marked . . . . . 10°, and so of the others. Nearly every circumstance essential to a correct understanding of the phenomena of the storm is thus presented to the eye at a single glance.

Chart 1. for the morning of February 15, represents the storm near its commencement, and before it had acquired much violence, or its features had become very distinctly marked. In the extreme north-eastern part of the United States, is seen a corner of a storm rapidly passing off. In the vicinity of Buffalo, a few particles of snow are falling, and the sky in its vicinity is overcast. Perhaps this may be ascribed to the vapour arising from the lakes, aided by the rise of ground as the current travels eastward, by which means the moist air at the surface is forced up to a region of greater elevation and cold, and its vapour condensed. With these exceptions, nearly the whole eastern and central portions of the United States are unclouded. But throughout the valley of the Mississippi, the heavens are obscured, and in the northern part some snow is falling. This is the commencement of the storm which I propose particularly to consider. Throughout the entire United States the barometer stands a little above the mean. The line of — — — + .2, is marked upon the chart. The thermometer no where stands much above its average for February. The line of mean temperature passes nearly through the middle of the United States; and that of 10° below the mean, is an undulating line in the eastern part of the United States. The direction of the winds is exceedingly various. In the eastern part of the United States, the winds are generally north-west, the result of the preceding storm. The weight and density of the atmosphere were here both greater than farther west. As you proceed westward, the wind moderates, becomes calm at many places, and in the central parts of the United States begins to set towards the west. Throughout the Mississippi valley the winds are neither very strong nor uniform in their directions;—a result to be expected, as there was no where any very considerable disturbance of mean temperature or pressure.

Chart 2 represents the features of the storm more fully developed. The snow has increased, dissolving into rain on its southern border; the cloudiness is still farther extended; the blue sky is mostly supplanted. In the eastern states, the pressure of the atmosphere has risen .4 inches above the mean under the influence of the westerly wind; and in the west, the barometer has fallen .4 inches under the influence of the storm. The temperature is generally near the mean, except in the east, where the thermometer is still 10° below the average. The winds are becoming more uniform and steady. Throughout a circle of nearly a thousand miles diameter, the prevalent tendency of the winds is inward towards the storm, with a slight disposition to circulate around this centre against the sun. By the morning of February 16, the storm had made sensible progress towards the east, and become much elongated. The greatest depression of the barometer in the centre of the storm is now .6 inches, and increases in each direction, standing .2 inches above the mean on the front of the storm. Here, also, the thermometer stands at its mean height; while, a little in advance of the centre, it stands 5° above the mean; a little behind the centre it stands at the mean, and in the rear 10° below the mean. The same law as just stated, holds true with regard to the winds. There is a prevalent tendency inward, with a disposition to circulate around the centre.

Chart 4 shows the storm still farther advanced. The area of rain is now nearly equal to that of the snow. The cloudiness in the rear of the storm is contracted into narrow limits, and blue sky covers nearly the entire United States. The barometer in the centre of the storm now stands .8 inch below the mean. It stands near the mean in the rear of the storm, and evidently as high and perhaps higher on the front. The thermometer near the middle of the storm stands 10° above the mean, and in the rear 20° below. The winds are now generally very strong and steady, exhibiting in a still more striking manner the phenomenon already alluded to, that of an inward tendency, with a disposition to circulate around the centre in a direction contrary to the sun's motion. On the morning of the 17th, only a part of the storm is included within the limits of the United States, and the observations are confined to one side of its centre, which is much to be regretted, as its violence was still increasing. The barometer stands 1.00 inch below the mean in the middle of the storm, and at the mean in the rear. The thermometer stands 20° above the mean in the middle of the storm, and 20° below the mean on the rear. The same law of the winds holds true. In the north-western part of the United States, cloudiness was commencing, which was followed by another storm about equally remarkable with the one we are considering. In the following table, column second shows the amount of snow at the different stations, and column third the total amount of water, including snow and rain.

STATION.	SNOW.	WATER.	STATION.	SNOW.	WATER.
	Inches.	Inches.		Inches.	Inches.
St. Louis,	Snow,	0.01	Detroit,	.25	.10
Fort Winnebago,	Snow,	0.4	Fort Gratiot,	Snow,	.06
Indianapolis,		0.018	Marietta,	1.5	
Cincinnati, (Ray,)	4.75	0.51	Hudson,		0.30
" (Williams,)	6	0.51	Ravenna,	5	
Fort Brady,	1.5		Meadville,	2	
Columbus,	5		Erie,	2	.167

STATION.	SNOW.	WATER.
	Inches.	Inches.
Pittsburgh,	2	
Alleghany Arsenal,		.15
Butler,	2	
Fort Niagara,		.20
Somerset,	3.5	
Lockport,	8	
Millville,		.12
Winchester, Va.,	6.5	
Huntingdon,	3.5	
Rochester,	4 or 5	
Bellefonte,	2.5	
Gettysburgh,	10.5	
Carlisle,		.833
Washington City,		.60
Northumberland,	11	
Fort M'Henry,		.70
Harrisburgh,	11	
Fort Monroe,		.60
Lancaster,	7	.675
Port Carbon,	11	
Madison Barracks,		.20
Sackett's Harbour,		.20
Casenovia,	20	1.80
West Chester,		1.15
Haverford,	1	
Utica,	12	

STATION.	SNOW.	WATER.
	Inches.	Inches.
Philada., (Evans,)		.873
" (Conrad,	Snow and Rain.	.900
Newtown,	1	1.160
Malone,		1.16
N.Y.City, (Jortin,)		.58
" (Fort Col.,)		.30
" (Fort Wood,)		.55
West Point,		.90
Albany,	Snow and Rain.	1.12
Watervliet Arsen.,	6	.36
North Salem,	Mostly Rain.	1.50
Plattsburgh,		.30
Montpelier, Vt.,	18	
Grafton, Vermont,	10	
Amherst,	1	.60
Hanover,	7	.80
Worcester,		1.31
Fort Adams,		.93
Cambridge,		.855
New Bedford,		.76
Fort Constitution,		.50
Fort Preble,		.90
Gardiner,	3	.69
Charleston, Me.,	6	
Fort Kent,	24	
Hancock Barracks,		.53
Fort Sullivan,		.15

From this table it will be seen that, in the extreme western states, but little snow fell; in Ohio, the average was not quite half an inch of water; in the interior of Pennsylvania and New York, about three quarters of an inch; and farther east, the average was about an inch:—amounting, on the northern border of Maine, to two feet of snow.

The following table contains all the stations where the direction of the clouds was recorded.

	February 15.			*February* 16.			*February* 17.		
Cincinnati,	W.		W.	W.N.W.			Clear.		
Hudson,	Clear.		W.S.W.	N.W.		N. N.W.	W.N.W.		W. S.W.
Meadville,				S.W.					
Erie,		W.				W.	W.N.W.		
Pittsburgh,				N.E.	N.W.	N.	N. N.W.		N. W.
Franklin,	Clear.	Clear.	S.E.	S.E.	S.E.	N.W.	N.W.	N.W.	Clear.
Union,		S.W.	S.W.	W.	W.	N.W.	W.		S.W.
Toronto,	W.	W.	N.W.	W.	N.W.	N.W.	N.	N.W.	N.W.
Bedford,		W.	S.	S.W.	N.W.	N.W.	N.W.	N.W.	
Bellefonte,	N.					N.	N.	N.	
Mifflintown,	N.W.					N.W.	N.W.	N.W.	
Gettysburgh,		W.	W.				N.W.		
Carlisle,	W.			E.			N.W.	N.W.	N.W.
Northumberland,	N.W.	W.	W.				N.W.	N.W.	
Port Carbon,	N.W.	W.						N.W.	
Lancaster,	N.N.W.	N.W.							
West Chester,							W.	W.	
Haverford,	N.W.	N.W.			S.W.		N.W.	N.W.	
Philadelphia,	N.W.	W.	S.W.	S.E.	S.E.	W.N.W.	W.	W.	
New York,	N.N.W.		W.N.W.	S.S.E.	E.S.E.	S.	W.S.W. / W.N.W.		
Middletown,	N.N.W.		N.W.	S.		S.	W.		W.N.W.
Amherst,				S.E.		S.E.			N.W.

The following table, showing the difference between the dew point and the external temperature at Hudson, will enable us to form some estimate of the lower limit of the clouds.

	Comp. Temp. dew point.	Height of Clouds.	Winds.	Clouds.
Feb. 15, 9 A. M.	4° 0′	400 Yards.	W. by S.	None.
" " 3 P. M.	17 2	1720	S. S. E.	W. S. W.
" 16, 9 A. M.	7	70	W. N. W.	N. W.
" " 3 P. M.	5 4	540	N. W. by N.	N. N. W.
" 17, 9 A. M.	7 8	780	W.	W. N. W.
" " 3 P. M.	12 3	1230	S. W. by S.	W. S. W.

The clouds were invariably from the west, and the winds generally so, but on the fifteenth, when the wind was easterly, the clouds at the height of a mile were from west-south-west.

Before commencing the inquiry into the causes of the phenomena of this storm, I propose briefly to review the phenomena of the storm of February 3.

Storm of February 3, 1842.

The most important features of this storm will be seen from the accompanying charts, numbers 6 to 13. I have called it one storm, though, perhaps, with more propriety, it might be called several; for it is obvious that there was more than one centre of action. On the first of February, at sunset, the storm was marshalling its forces. No rain had fallen, but clouds had formed in four different places, as seen by chart 6, in the north-east, north-west, south-east, and south-west parts of the United States, respectively. The chief of these was in the south-west, and from this, during the succeeding night, was discharged a torrent of rain. Chart 7 shows the condition of the storm the next morning. The north-east cloud had greatly expanded, but had yielded no rain. The north-west and south-east clouds had deposited a little rain; but the south-west cloud had poured down rain over a circle at least seven hundred miles in diameter. Before sunset of the second, the north-east cloud had expanded still farther, but without rain. The south-east cloud had ceased to rain; the north-west cloud had become blended with the south-west, and rain was now falling over an area about one thousand miles long by five hundred broad. Before morning of the third, rain burst forth in torrents from the north-east cloud, and united with the south-west, so that the area of rain was, at least, seventeen hundred miles long, from south-west to north-east, and in its greatest breadth at least nine hundred miles. Upon the northern margin of the storm was a band of snow. Before sunset, this storm became broken into three considerable portions; the south-west being the largest. The clouds became somewhat broken, and in the north-east the rain was generally moderate, amounting, in many places, to a mere drizzle, and at others bringing a dense fog. Before the morning of the fourth, the storm became still farther broken into five small patches of rain, with numerous openings through which clear sky

could be seen. By sunset, one of these patches of rain had assumed a very regular figure. It was about three hundred and sixty miles by two hundred and eighty, and lay directly over lake Erie, being fringed with snow upon its northern border. Near the middle of this ellipse, occurred a remarkable tornado, of which an account is given in the American Journal, Volume xliii., page 278. The clouds were much more broken than in the morning. By sunrise of the fifth, the whole was driven into the north-east corner of the United States.

The following table shows the amount of rain during the entire continuance of the storm, for the western, middle, and eastern parts of the United States.

WESTERN.		MIDDLE.		EASTERN.	
Fort Towson,	4.70	Hudson,	2.277	Hanover,	1.68
Fort Jesup,	4.11	Meadville,	2.128	Watervliet Arsenal,	1.40
Nashville,	3.85	Casenovia,	1.99	Gardiner,	1.32
Natchez,	3.56	Ebensburgh,	1.856	Fort Sullivan,	1.25
Fort Smith,	3.40	Marietta,	1.75	Williamstown,	1.23
Cincinnati, (Williams,)	2.99	Erie,	1.675	Fort Preble,	1.2
" (Ray,)	2.57	Fort Niagara,	1.60	Fort Adams,	1.07
Vicksburgh,	2.91	Pittsburgh,	1.52	Albany,	1.03
Cedar Keys,	2.10	" (Arsenal,)	1.51	Providence,	.88
Louisville,	2.09	Bellefonte,	1.501	North Salem,	.80
Portsmouth, Ohio,	2.00	Butler,	1.445	Malone,	.75
Detroit, (Duffield,)	1.681	Franklin, Penna.,	1.3	Amherst,	.71
" (U. S.,)	1.00	Fort Monroe,	1.2	New Bedford,	.70
New Orleans,	1.15	Huntingdon,	1.017	Hancock Barracks,	.70
" "	1.1	Northumberland,	.992	Plattsburgh,	.60
Fort Brady,	1.0	Rochester,	.99	West Point,	.60
Dearbornville,	.90	Millville,	.98	Worcester,	.60
Fort Gratiot,	.80	Port Carbon,	.933	Haverford,	.523
St. Louis,	.72	Madison Barracks,	.90	New York,	.51
Jefferson Barracks,	.40	Somerset,	.88	" (Fort Col.,)	.50
Fort Gibson,	.30	Washington City,	.708	" (Fort Wood,)	.09
Fort Winnebago,	.10	Savannah,	.480	Cambridge,	.371
Fort Leavenworth,	.00	Gettysburgh,	.285	Fort Constitution,	.33
Fort Crawford,	.00	Carlisle,	.283	Philadelphia,	.30
		Mifflintown,	.120	" (Conrad,)	.286
		Lancaster,	.10	West Chester,	.26
				Newtown,	.190

Thus it appears that, in the south-west, there was a considerable area over which the fall of rain must have averaged three inches; in the vicinity of Ohio, probably throughout the entire state, two inches fell; while throughout a considerable part of New England the fall averaged about one inch. It rained in the south-west about forty-two hours. At Hudson, from the beginning to the end of the rain was a little more than two days; it rained steadily about thirty-five hours. At Hanover, it rained about twenty-four hours, but from the beginning to the end of the rain was fifty-one hours.

The following table contains all the stations where the direction of the clouds was recorded.

	February 1.	*February* 2.	*February* 3.	*February* 4.	*Feb.* 5.
Cincinnati,	W.	S. W. S.W.	S. W. S. W.	S. W.	W. S.W.
Hudson,	W.N.W.	W. S. S. W.	S. W. W. S.W.	S.E. rain. S.	W.N.W.
Meadville,	W.		S. S.	S.	W.N.W.
Erie,		W.	W.S. W. W. S.W.	W. W. W. S.W.	N.W.
Pittsburgh,	S. W.	S.W.	S. W. W. S.W.	E.N.E. S. E.	N.W.
Franklin,				S. E.	N.W.
Union,		S. W. S. W.	S. W. S. W.	S. W. S. W.	N.W.
Toronto,	W.	W. W.	S. W. W.	W. S.E. rain. E. rain.	N.W.
Bedford,		N. W. S. W.	S. W. S. W.	S. W. S. W.	N.W.
Bellefonte,	W.		W. W.		W.
Mifflintown,			S. W. S.W.	S. W. W.	N.W.
Gettysburgh,		W. W.	S. S. S.W.	S. S.W. S. W.	W.
Carlisle,	N. W.	W.	S. W. S. W.	S. W. W.	N.W.
Northumberland,	N. W.	W. N. W.	S. W. S.W.	W. S.	N.W.
Port Carbon,				N. S. S. W.	N.W.
Lancaster,		W.		S. W. S. W.	N.W.
West Chester,	W.	W. S.	S. S.	W. S. W.	W.
Haverford,	W.	N. W. W.	W. S.W. W.	S. W. W.S.W.	N.W.
Philadelphia,		W. W.	S. S.W.	S.S. W. S.	W. S.W.
New York,	N. W.	W. W.	W. W. S.W. S.W.	W. W.S.W. W.	W.
Middletown,	N.N.W.	W. W.	S. W. S. W.	W. W.	W.
Amherst,	N. W.		S. W.	N.W. S.W.	N.W

This table exhibits a remarkable uniformity; the direction being almost invariably from the west. Only six observations in one hundred and forty-six are from the east, and, in one of these cases, higher clouds were seen from the west, and in each of the other cases rain was falling. These observations indicate the direction of the wind in the region of the clouds observed. When rain is falling, the clouds are usually low, and have nearly the direction of the wind at the surface, although a higher current may still be blowing from a different direction. There seems, then, no room to doubt that throughout the entire period of these observations a westerly wind prevailed at a certain elevation from the earth's surface. The following observations of the dew point at Hudson afford some data for judging of this elevation.

	Comp. Temp. dew point.	Height of Clouds.	Direction.
Feb. 1, 3 P. M.	9° 5′	950 Yards.	W. N.W.
" 2, 9 A. M.	8 4	840	W.
" " 3 P. M.	5 4	540	S. S. W.
" 3, 9 A. M.	1 0	100	S. W.
" " 3 P. M.	4 0	400	W. S.W.
" 4, 9 A. M.	0 0	000	S. E.
" " 3 P. M.	5 6	560	S.
" 5, 9 A. M.	1 2	120	W. N.W.

It will be perceived that these clouds were all quite low, the highest southerly cloud being a third of a mile in elevation. It is inferred that at an elevation of a mile or so, the winds were invariably from some western quarter.

With this general review of the *facts* respecting these two storms, let us proceed to a more particular consideration of their causes.

I. OSCILLATION OF THE THERMOMETER.

Both of these storms, as well as that of December 20, 1836, were accompanied by a considerable elevation of the thermometer. Under this last storm, the thermometer rose 20° above its mean height; February 17, 1842, it rose the same; and February 4, 1842, it rose 30° above the mean. What is the cause of this extraordinary temperature? The three following causes may be supposed to contribute to the effect.

1. Diminished radiation, in consequence of the sky being covered with clouds.
2. The heat evolved in the condensation of vapour.
3. The transfer of air from a more southern latitude.

The first of these causes can have but a limited influence. We may estimate the amount by comparing the means of observations made in clear and cloudy weather. The observations on the accompanying charts correspond about to the hours of sunrise and sunset. The following results I have deduced from observations made by Mr. Bond, at Cambridge. Column first shows the mean temperature, at sunrise, when the cloudiness was less than five tenths; column second, the temperature of the rest of the month.

	CLEAR.	CLOUDY.	DIFF.
December, 1841,	21°.4	30°.1	8°.7
January, 1842,	16 .6	30 .8	14 .2
February, 1842,	20 .4	31 .2	10 .8
Mean, ...			11 .8

According to these observations, in the winter, at Cambridge, the thermometer for clear mornings, stands 5°.9 below the mean, and on cloudy mornings the same above. We may estimate the effect of radiation then, at 5°. We have still to be accounted for, an elevation of 15° in two storms, and of 25° in the other. Can this be ascribed to the heat evolved in the condensation of vapour? The heat evolved in the precipitation of one inch of water, is sufficient to raise the temperature of the surrounding atmosphere about ten degrees. The fall of water, in these storms, was very great. Does not this explain the whole rise of the thermometer? I infer not, for the following reasons:

1. The rise of the thermometer was not proportioned to the amount of rain. Thus in the storm of February 4, the rain averaged three inches for a large area in the south-west; in Ohio, about two inches; in New England, one inch. The greatest rise of the thermometer in the south-west, was 20°, and in New England, 30°.

2. In tropical countries, where the range of the thermometer is least, the fall of rain is the greatest. Thus at Singapore, latitude 1° 20′ north, according to a register published in Silliman's Journal, Volume xliv., page 151, the entire range of the thermometer for sixteen months was 21°.3, while the fall of rain for one year was ninety-three inches. At Bombay, the average fall of rain for June is twenty-four inches, and the same for July. More than twice this quantity has repeatedly fallen in one month. June 23, 1817, 9.03 inches of water fell, and on the next day, in a period of nine hours, 7.23 inches fell, yet the entire range of the thermometer, for the month, was only 12°, and the thermome-

ter at no time rose 7° above the mean. According to the reports of the British Association for 1839, page 15, on the Ghâts of Western India, there fell, in 1834, 302 inches of rain, (= 25 feet,) of which 118 fell in July, while the mean variation of temperature for the month was only *three* degrees! These extraordinary rains seem rather to cool than heat the atmosphere at the surface.

3. The reason of this last remark will appear from observations of the temperature of the fallen water. According to observations at Cuba, published in Silliman's Journal, Volume xxxi., page 289, the mean temperature of falling rain water, was more than eight degrees below the mean temperature of the locality. The reason is obvious. The precipitation takes place at a great elevation, and the water descends with the temperature of that region. This cold shower, mingling with the air at the surface, lowers its temperature, or prevents that elevation of temperature which might be expected from the heat liberated in the condensation of the vapour. I do not see, then, how we can ascribe any considerable part of the effect in question to the heat of the condensed vapour. Can it, then, be ascribed wholly to a change of latitude of the wind? On the Atlantic coast, in winter, the change of temperature is 15° for 10° of latitude. In the interior the change of temperature is greater. Thus,

Temperature of Fort Churchill,	latitude	58° 57′	north,	in winter is	20°.23.
" " Hudson,	"	41 15	"	"	27 .68
		17° 42′			47°.91

Or 27°.1 for ten degrees of latitude.

Temperature of Fort Snelling,	latitude	44° 53′	north,	in winter is	16°.70.
" " Natchez,	"	31 34	"	"	50 .32
		13° 19′			33°.62

Or 25°.2 for ten degrees of latitude.

Over how many degrees of latitude did the wind in question blow? On the morning of February 17, 1842, the thermometer, in Maine, stood 20° above the mean. Allowing five degrees for radiation, we have an effect of 15° to be accounted for. The wind had been blowing from the southward about twenty-four hours, with an average velocity of about forty miles per hour, equal to nine hundred and sixty miles, which probably corresponds to six hundred and seventy-nine miles in the direction of a meridian, or nearly ten degrees of latitude. This wind might, consequently, have come from Bermuda.

The temperature of Bermuda,	latitude	32° 34′	in winter	is	59°.11.
" " Eastport,	"	44 54	"	"	22 .42
Effect of latitude, ...		12° 20′			36°.69

Or 29°.7 for ten degrees of latitude. This air, then, should have an excess of heat much greater than that actually observed, provided that none was lost in the transfer. We may allow a loss of one half, and still have an excess sufficient to satisfy the observations.

December 21, 1836, the temperature in New England was also 20° above the mean.

The wind had been blowing from the southward about the same time, and with the same force, as February 17.

On the morning of February 2, 1842, the temperature in Arkansas was 20° above the mean. The winds were southerly, and had been so for the preceding day over a considerable district, in which time the wind might have travelled ten degrees of latitude.

Temperature of Havanna,	latitude	23° 10′	in winter is		72°.22.
" Natchez,	"	31 34	"	"	50 .32
Effect of latitude, . . .		8° 24′			21°.90

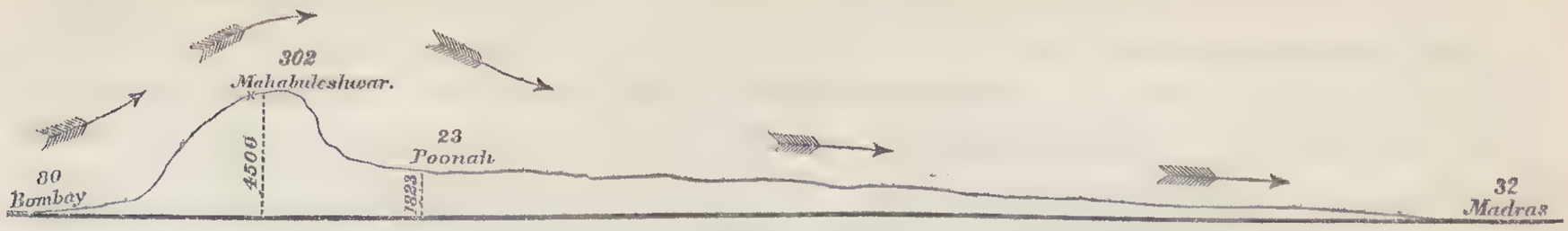
Or 26°.1 for ten degrees of latitude.

We may thus make a liberal allowance for loss of heat in travelling northward, and still explain the whole effect observed. February 3, 1842, in the morning, the thermometer, in the western part of Pennsylvania, stood 30° above the mean; the same in the centre of New York state in the evening; and also throughout the 4th, in the vicinity of Philadelphia. February 3, at Pittsburgh, the wind had been blowing about thirty hours from the southward, in which time it might have travelled 12° of latitude, giving an elevation of about eighteen degrees, which, allowing for the loss of heat in travelling northward, is not more than half enough. Our explanation, then, seems to fail. It should be remembered, however, that in estimating the effect of a particular storm, our standard should be, not the mean temperature of a long period of years, but rather of a few days just preceding the storm. The temperature of January, was, throughout most of the United States, five degrees above the mean. Allowing also, five degrees, for radiation, we have only an effect of twenty degrees to be explained. About half of this effect may be ascribed to simple change of latitude; and when it is remembered that over a large area in the south-west, the thermometer stood 20° above the mean, and that this heated air was transported mostly towards the north-east, we have a cause sufficient to explain the whole effect in question.

To explain the cold which succeeds the storm. After the storm of February 4, the thermometer no where sunk much below the mean. A north-west wind succeeded the storm, yet it was not of long continuance, and its cold was neutralized by the extraordinary elevation of temperature which preceded it. After the storm of February 16, the thermometer generally sunk 20° below the mean. This wind was very strong, and probably travelled full ten degrees of latitude. After the storm of December 20, 1836, the thermometer, in the neighbourhood of the Mississippi, sunk from 30° to 40° below the mean. The entire month of December, 1836, was a little below the mean, but not more than a degree or two. It seems necessary to admit that this current travelled more than fifteen degrees of latitude; a supposition, I think, not inadmissible.

II. CAUSE OF THE RAIN.

We may be guided in our inquiry for the cause of the rain by comparing the circumstances of two extreme cases, where no rain falls and where it falls most abundantly. Such an example we find in India. At Bombay the average fall of rain is eighty inches,



and it falls wholly from June to October, under the south-west monsoon. This wind blows over a range of mountains varying from one thousand to eight thousand feet in height. At Mahabuleshwar, at an elevation of four thousand five hundred feet, the fall of rain, in 1834, was three hundred and two inches, and almost wholly with the south-west monsoon. At Poonah, on the eastern side of the mountains, elevated one thousand eight hundred and twenty-three feet, the annual fall of rain is only twenty-three inches, while, at Madras, it is thirty-two inches. By the interposed range of mountains, the humid air from the ocean is cooled, and the windward slope of the mountain is deluged with rain. The case is quite analogous with a southerly wind in the United States. A south wind from the level of the sea encounters land every where swelling to the height of several hundred feet, and rising in ridges and insulated peaks to the height of four or five thousand feet. A copious precipitation must be the consequence. But it is not wholly by elevation that the rain is caused; the effect is increased by collision with the upper current flowing in a different direction. The winds marked on the charts are merely surface winds; but from the observations, pages 166 and 169, there is reason to believe that the whole upper part of the atmosphere was pursuing its course undisturbed from the south-west or west over the entire United States. Suppose the lower current coincide in direction with the upper: then the whole atmosphere moves on as one mass, there is no mingling of strata of unequal temperature, and no cause for the formation of cloud. Suppose, however, the direction of the lower stratum is changed, while that of the upper continues, then we have two currents rubbing upon each other, generally of unequal temperature, differing also, perhaps, in their amount of moisture. There will be a partial mingling, and, of course, cloud formed. It seems then hardly possible that the lower current should change its direction to a warmer quarter, and continue thus for many hours without the formation of cloud, and followed by the production of rain.

The effect of an elevated ridge of land appears sensible in the difference of climate upon the two sides of the Alleghanies. The region immediately west of that range of mountains has a sensibly greater degree of cloudiness, (particularly in winter,) than places on the east side. This appears from the following table of averages, (0) representing a sky perfectly clear, (10) entirely overcast.

	HUDSON, O.		HANOVER, N.H.			CAMBRIDGE, MASS.			
	9 A. M.	3 P. M.	Sunrise	1½ P.M.	9½ P.M.	Sunrise	9 A. M.	3 P. M.	9 P. M.
Spring,	5.70	5.91	3.93	4.02	3.55	5.50	5.80	6.33	5.53
Summer,	5.22	5.57	5.43	3.41	2.92	5.43	5.23	5.33	4.90
Autumn,	5.96	6.20	5.66	4.34	3.54	5.77	5.60	5.93	4.53
Winter,	8.07	7.87	4.65	4.30	4.14	5.20	6.00	5.67	4.80
Year,	6.24	6.39	4.92	4.02	3.54	5.47	5.66	5.81	4.94

The prevalent westerly winds glancing up over the Alleghany ridge deposit a portion of their vapour, forming cloud on the western slope, particularly in winter, when these winds are usually strongest, and the dew point differs least from the temperature of the air. It is thought that the operation of this principle may be traced in the storms of February, 1842. On the fourth, at sunset, the clouds were very much broken, particularly on the east slope of the Alleghanies, while cloud, and in some places rain, still lingered on the west slope. As the westerly wind pours over the mountains and descends to the level of the sea, it comes under greater pressure, and heat is developed, which dissolves the precipitated vapour, producing clear sky. Thus clear sky succeeds a storm much sooner on the eastern than on the western side of the mountains. The same is seen at sunset on the sixteenth, the clear sky advancing with great rapidity on the southern border of the storm.

I do not regard the configuration of the earth's surface as the main cause of storms in the United States, but only as an auxiliary and modifying cause. The same effect which is produced by an interposed mountain is produced by the apposition of surface winds, by which means a mass of air is elevated into a region of greater cold.

III. THE MOTIONS OF THE WIND.

That an easterly wind should spring up on the morning of February 15, in the region of Ohio, was the necessary result of the greater weight and density of the air to the eastward. But a westerly wind, at the same time, prevailed a little beyond the Mississippi river. These two winds were partially opposed, and from this opposition the air between them was elevated somewhat above the surface of the earth. Being cooled by diminished pressure, its vapour is condensed, a portion of it falls as snow, and the remainder forms cloud which expands and covers the surrounding country. The condensation of the first vapour developed heat, which diminished the specific gravity of the surrounding air, thereby causing a more decided tendency towards the storm, which increased the precipitation and the development of heat, so that the storm increased in violence as it continued. In the region of the greatest condensation, the rise of temperature was probably greater than at the surface of the earth. As the result of this rarefaction, the air swells up above its usual height, and flows off in every direction, carrying with it the cloud already formed, and causing the barometer to fall steadily as the storm continues to rage. Let us examine particularly the case of a body of air, from the earth's surface, forced up to a considerable elevation.

According to Poisson, "Nous manquons des données nécessaires pour la solution complète de ce problême;" nevertheless, I propose to inquire to what extent the problem is undetermined. Gay Lussac, in his aeronautic ascent to the height of twenty-three thousand feet, found the thermometer fall 1° F. for three hundred and seventeen feet elevation. According to Professor Forbes, the mean decrease, in Europe, is 1° for three hundred and fifty-two feet; according to Pouillet, three hundred and sixty-four feet in the equatorial regions, and three hundred and nineteen in Europe; according to Lubbock, 1° for three hundred and forty feet. If we assume 1° for three hundred and thirty feet, we cannot be far from the truth. According to Leslie, the heat liberated, when air has its density

doubled, is 67½° F., and the same quantity is withdrawn when air of the ordinary state expands into double its volume. According to the experiments of Desormes and Clement, the heat is greater than this. When we consider the extreme mobility of the atmosphere, it can hardly be doubted that the cold of expansion is almost identically that which prevails ordinarily in the higher regions of the atmosphere, and that, when vapour is condensed by the cold of diminished pressure, the heat evolved raises the temperature of the surrounding air above that which is proper to this height, and it is thus elevated still farther by its own buoyancy.

In some parts of the Arctic regions, clouds are almost unknown in the winter. The reason is obvious. The temperature is constantly below zero, and the tension of vapour can seldom rise as high as 0.068. If all this vapour should be condensed, it would raise the temperature of the air only 7°; so that if air from the earth's surface could be mechanically elevated to a great height, its temperature, notwithstanding the condensed vapour, could hardly exceed, perhaps not equal, that of the surrounding air. Hence there is little opportunity for ascending currents, and consequently no cloud.

Let us begin with the first formation of cloud on the western border of the United States, which happened a little before sunrise of February 15. The heat liberated in the formation of this cloud raises the thermometer, causing a more decided tendency of the air inward towards the region of condensation. The whole heavens being covered with a veil, radiation from the earth's surface is checked, while it is going on beyond the region of the cloud. This causes a relative elevation of temperature under the cloud, and gives increased velocity to the inward current of air. More cloud is thus formed, heat is liberated: the air, expanded, swells up beyond its usual limits, and flows over in every direction, carrying with it the snow formed, which, while suspended in the air, appears merely as cloud, causing the barometer to fall gradually in the centre of the storm. Thus the storm gains violence by its own action, and being floated eastward by the prevalent westerly current, it ceases in the western states, while it is still raging with increased violence in the east. The winds might then be expected to flow inward towards the centre of the storm. As, however, the storm covers a large area and is somewhat irregular in shape, the winds could not all blow towards one point. Moreover, such a central tendency, whether in air or water, uniformly causes the fluid to approach the centre, not exactly in radii, but circuitously. This effect can hardly be detected on the chart for the fifteenth, at sunrise, but at sunset a slight tendency may be perceived, to circulate against the sun. On the sixteenth, at sunrise, the phenomenon is more strongly marked, and at sunset it is impossible to overlook it. There is a physical cause for this rotation, and for its being uniform in direction, in the case of large storms. The southerly wind has a greater motion eastward than the parallels upon which it successively arrives, arising from the rotation of the earth; and the northerly wind a less motion eastward, or a relative motion westward. Hence in this region the circulation, in great storms, is probably invariable in direction.

On the chart of February 15, at sunset, we see in a striking light, the effect of the upper current. The condensed vapour as it rose spread out in every direction, but only slightly westward, while eastward it extended nearly four hundred miles in advance of the snow. On the southern border, the temperature is such as to melt the flakes of

snow as they fall, producing rain; and as the heat of the storm increases, the breadth of the rain increases to beyond the limits of the United States, and this, although the storm was continually advancing to a higher latitude. As the storm continued, the north-west wind which succeeded it set in with increased violence towards this region of rarefaction, producing a sudden depression of the thermometer, amounting to more than twenty degrees below the mean.

Two questions here naturally arise. First, What caused the formation of the first cloud on the morning of the fifteenth? and secondly, Why should the storm once organized ever cease? This first cloud I ascribe to the superior weight and density of the air in the central parts of the United States. This superior weight was the result of a storm experienced in the same region two days previous, the margin of which is seen upon the extreme east border of chart 1. So also the low temperature which succeeded the present storm, as exhibited in chart 5, produced a similar easterly wind, causing a cloud which is seen upon the extreme left of the chart, which grew into a storm of nearly equal violence with that we are now considering. Thus, one storm begets its successor. The undulations thus excited in the atmosphere bear considerable analogy to the waves of the ocean agitated by a tempest, and which are propagated by mechanical laws long after the first exciting cause has ceased to act.

Secondly, It may be thought, if the explanations here given are well founded, that when a storm is once organized it should go on increasing in violence, and never cease raining while there was vapour to be precipitated. By inspecting the annexed charts, I think we shall see a principle in operation which must prevent any considerable further increase of violence, and soon cause it to decline. On chart 3, the line of — 20° is distant about seven hundred miles from that of + 5°; on chart 4, it is distant only five hundred miles from that of + 10°; and on chart 5, it is less than five hundred miles from the line of + 20°. The line of mean temperature is only one hundred and sixty miles from that of + 20°. This cold north-west wave advanced more rapidly than the centre of the storm. It was beginning to counteract the increase of temperature arising from the condensed vapour, and after that the violence of the storm must rapidly decline.

Let us now turn to the storm of February 4. Beginning with February 1, sunset, we find the barometer at its mean height near the valley of the Mississippi, and .3 inch above the mean in the vicinity of New York. The thermometer stood 10° above the mean near the Mississippi, while farther east it stood at the mean. For both of these reasons there should be an easterly wind near the Mississippi. This easterly wind encountering the prevalent westerly wind beyond the United States, which is seen on the chart the next morning, is lifted from the surface and a portion of its vapour is condensed, forming cloud. This is the origin of the two clouds near the Mississippi. No great elevation is requisite to produce this effect. Although the dew point at the earth's surface may be low, there is always a point, not very elevated, where the air is saturated with vapour. Any increased elevation of this stratum will cause a precipitation of moisture. Cloud being once formed in considerable quantity, contains within itself the principle of rain. The easterly winds become more general and strong, and the precipitated vapour soon reaches the earth in the form of rain. In the eastern states the winds were strong from the north-west, the result of the storm which had prevailed the day previous.

Between these easterly and westerly winds we find a region of calms marked on the chart. The formation of the north-east cloud I suppose to be as follows. The pressure of the atmosphere was greater near the Atlantic than towards Lake Ontario. This must give a check to the north-west wind from the lake, causing a part of it to glance upward, forming cloud. The probability of this explanation will be seen from chart 7, where the cloud is much extended, and the winds are generally blowing from the south. The same causes produced a north-east wind on the south-east border of the United States, which, being opposed to wind from the gulf, formed cloud. By the morning of the second, these clouds were all partially united. The south-west pours down rain. The winds are generally westward on the west border, and eastward on the east border. The thermometer has risen a little, and the barometer fallen .2 inch. No sudden fall could be expected, considering the great extent of the storm. The north-west cloud seems almost to have lost its distinct existence; but in the north-east the winds are blowing from the region of greatest pressure, and cold towards the cloud. The south-east cloud had already deposited a little rain. The barometer, in New England, continued to rise, notwithstanding the drain of air by the southerly winds. The air over the St. Lawrence being expanded, swelled up, overflowing New England, and more than compensating for the drain of the lower current. At sunset we find the same causes in operation. The barometer had fallen .6 inch below the mean in the valley of the Mississippi, and this may be regarded as the principal centre of the storm. The winds are now southerly throughout almost the entire United States. The cloud along the valley of the St. Lawrence was now greatly expanded, and ready to pour down rain. Its temperature had risen 20° above the mean. The winds on the south were blowing directly towards it, and probably also on the north. It might be expected that the winds would blow from every quarter towards the barometric minimum near St. Louis. In point of fact, the south-east winds extended much farther north. No doubt, however, north-west winds prevailed at a considerable distance northward, and they showed themselves with great force within the United States on the morning of the fourth. But the storm evidently extended in a north-west direction much beyond the limits of the United States, and the irregularities of the wind are owing to the fact, that the pressure and temperature were so nearly uniform over so large a territory. On the morning of the third the north-east cloud had discharged its contents. The reason that this rain was so long in falling, (more than a day from the first formation of the cloud,) probably was, that the condensed vapour was frozen and the cloud was one mass of snow. The heat liberated by the continued condensation and by the transfer of air from a lower latitude, in time melted it, and it fell in a general deluge. The diminution of pressure in the vicinity of Lake Erie is now quite noticeable, being .6 inch below the mean, and the temperature has risen 30° above the mean; so that this is now the principal centre of the storm, and the north winds are now showing themselves at Montreal and Fort Kent. By sunset of the third, the clouds had become somewhat broken, and the rain had entirely ceased at some places, while it was reduced to a mere drizzle at others. We now see a general tendency of the wind inward from all the borders of the United States. On the south border the winds are, without exception, from the south; on the south-west they are from the west, and on the north border they are from the north. This is a necessary consequence of the elevated tempe-

rature and diminished pressure within the United States, and we can only account for the long delay of this inward rush, by supposing that a similar state of things prevailed far to the north of the United States. To know the full extent of this storm, we need observations far more extensive than I have been able to obtain. The storm is now sure to be contracted within narrower limits. On the morning of the fourth, the rain was very much reduced, and two very distinct centres of diminished pressure are shown, one near Boston and the other near St. Louis. Near Boston the pressure is at a minimum, and the temperature at a maximum, and there is a tendency of the winds inward, with a disposition to circulate against the sun. Thus in the vicinity of the North river, the winds are north; along the Sound they are south-west, and at Gardiner in Maine, they are north-east. In the vicinity of St. Louis the same fact is observable. At sunset of the fourth, some indications of subordinate centres of action may be noticed near New York and in New Hampshire; but throughout almost the rest of the United States, the winds are plainly governed by one centre near the middle of Lake Erie. Here the pressure is least, and the winds, taken as a whole, plainly circulate around this centre, with considerable tendency inward. Thus on the north side the winds are north-east; on the west side, generally north-west; on the south side, west and south-west; and on the east side, generally east, except towards New England, where there are to be seen other centres of action. Here, in the centre of this ellipse, was formed a violent tornado, exhibiting features very similar to those already described; namely, an inward motion of the air, and a circulation against the sun. The cause of this tornado is now obvious. Although its effects were mainly local, its origin was far otherwise. The centre of this vacuum travelled north 62° 17′ east, eight hundred and sixty miles in twenty-four hours, equal to thirty-six miles per hour. The tornado in question travelled north 33° 30′ east, and if we suppose it to have kept pace with the vacuum, the velocity of the tornado must have been forty-one statute miles per hour, a result a little greater than I have given in my published account of the tornado, derived, however, from a much less number of observations.

On the morning of the fifth, the storm was driven into the north-east corner of the United States, but exhibited features very similar to those of the previous evening.

IV. OSCILLATION OF THE BAROMETER.

Local changes in the density of the atmosphere seem to be the chief cause of the oscillations of the barometer; nevertheless these oscillations are propagated by the laws of waves, and are felt much beyond the limits of the original disturbing cause. As this is a very important principle, I propose to adduce conclusive evidence of it. This principle, then, is shown by the fact, that the barometric depression, of which the storm is the centre, often extends beyond the limits of the storm. Thus February 3 and 4, there was considerable depression of the barometer south of the region of rain, or even cloud. This phenomenon must be still more striking in higher latitudes. Thus at Melville island, Captain Parry found the sky generally clear. Though it was sometimes overcast or obscured by a slight general haziness, there were no separate clouds. Some well defined clouds appeared on the sixteenth of April, which were nearly the first that had

been seen. There would seem to be here very little cause for any oscillation of the barometer, and it is probable that if the entire surface of the globe were in the same situation, the variations of pressure would not exceed a small fraction of an inch. The range of the barometer observed at Melville island, December, 1819, was 1.65 inch; January, 1820, 1.18 inch; February, .83 inch; range for the winter months, 1.67 inches, which is equal to the extreme range which has been observed in Hudson in a period of five years. There can be little doubt that these oscillations are mainly the effect of storms prevailing in lower latitudes.

The storm of February 4 was quite extraordinary—for its extent, amount of rain, and long continued elevated temperature; nevertheless it is presumed, in its main features, to resemble our ordinary January thaws.

There was another phenomenon incidentally connected with the storm of February 16, which deserves a passing notice. Halos were observed at several places, during the period in question. The following are some of the observations.

Washington city, February 15, from 6 hours 15 minutes to 8 hours P. M., a perfect lunar halo.

Detroit, February 15, 10 A. M., halo round the sun.
Detroit, February 16, 10 A. M., halo round the sun.
Detroit, February 17, 8 to 10 P. M., halo round the moon.
Toronto, February 16, 8 P. M., imperfect halo round the moon, diameter about 35°.
Fort Gratiot, February 17, halo round the moon.
Hudson, February 17, evening, halo observed.
Fort Constitution, February 17, P. M., parhelion.

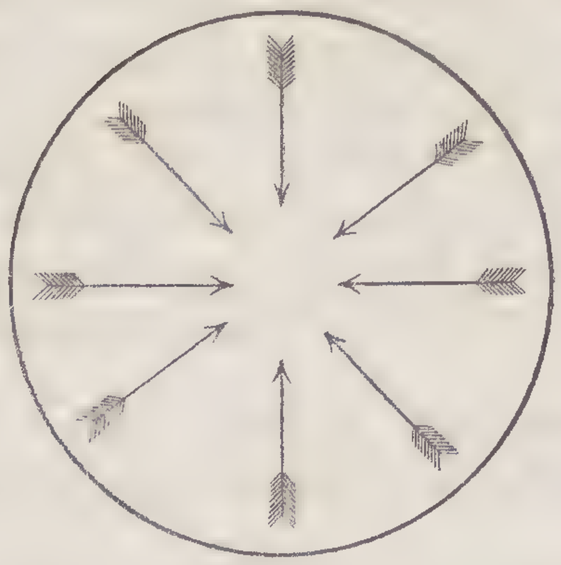
The halos observed on the fifteenth, at Detroit and Washington, were formed in that cloud which is represented on chart 2, which at first was a mere haze, and gradually thickened. February 16, another halo was formed at Detroit and Toronto, in the cloud which followed the storm; and on the seventeenth, a halo was noticed at three places together with a parhelion. If any doubt previously existed as to the cause of this phenomenon, the facts which have already been presented may serve to dissipate it. The argument may be thus stated. A halo of 22° radius would be formed by the refraction of the light of the sun or moon through prisms of ice, having angles of 60° and floating irregularly in the atmosphere. The halo is proved to be formed by refraction. Snow consists chiefly of spiculæ having angles of 60°. Flakes of snow were floating in the atmosphere, February 15, over Detroit and Washington. The halos observed were, therefore, formed by light refracted through these prisms.

GENERALIZATIONS.

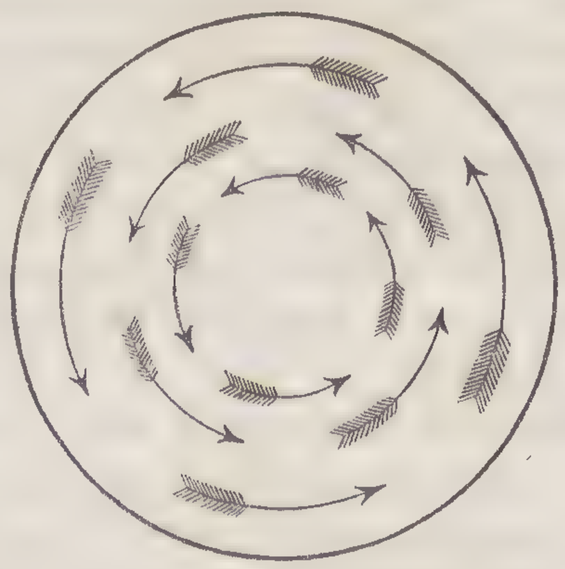
I. DIRECTION OF THE WIND.

The question which has, within a few years, excited most interest in Meteorology, is, whether storms are rotary or centripetal, and it has been supposed that either diagram, No. 1 or No. 2, must represent the motion of the wind.

No. 1.



No. 2.



The accompanying charts will show that neither of these diagrams faithfully represents the storms here investigated, and it is doubtful whether either of them ever accurately represents the motion of the wind over any large portion of the earth's surface. The storm of December 15, 1839, has been quoted as a strong case of the revolving kind, and if we take only a semicircle of two hundred miles radius on the north-west side of the centre, the correspondence is very good, (see Mr. Redfield's diagram, Philosophical Transactions Volume viii., page 81,) though, even here, most of the arrows are inclined to the circumferences drawn, and, as Mr. Redfield has remarked, the direction is generally *inward* towards the centre of the storm. But if we take the other half of the semicircle, which Mr. Redfield has omitted, the circles are not completed. There have been several cases, of limited extent, in which the winds might be represented by figure No. 1.; but I have seen no account of a storm, of a hundred or more miles in diameter, in which the winds could be faithfully represented by either of the above diagrams. A combination of the two is, however, frequently seen. No. 3 is intended to represent the motions of the

No. 3.

No. 4.

wind February 16, 1842, at sunset, near the centre of the storm. Substantially the same diagram is applicable for the morning of the seventeenth, so far as appears from the observation, and tolerably well for the morning of the sixteenth, although there is here more irregularity, the storm being of larger dimensions and less violent. The lower half of this diagram represents, very faithfully, the observations for the morning of December 21, 1836; and it may be inferred that if observations could be procured from more northern stations, they would show the other half of the diagram. The same figure

represents, pretty accurately, the storm of January 26, 1839, also the great British storm of August 17, 1840, and that of January 6, 1839, except that in the south-west quarter of the latter, the winds were, perhaps, more south-westerly.

Diagram No. 4, represents the storm of March 17, 1838, the north-east wind covering more than half the region of rain and snow. The storm of December 15, 1839, was quite similar to this last, though the north-east wind covered a smaller portion of the storm. In some storms there is a predominance of north-east winds; in others of the south-east; in some north-west, and others south-west winds; but in all we find certain common characteristics, namely, an inward motion, with a tendency to circulate against the sun. These are the ordinary features of those storms which are accompanied by a gust and sudden oscillation of the barometer. The storm of February 3, 1842, can hardly be comprehended under this class. It was so extensive, the motion of the barometer so slow, and the winds moderate on the second and third, that it seems more properly to belong to a distinct class; although on the fourth and fifth, when the winds sprung up with some force, we find the characteristics mentioned above.

II. PROGRESS OF THE STORM.

A second question of some importance is, in what direction and with what velocity does the storm advance? It is not difficult to perceive that the general progress of storms is eastward, but, when we undertake to assign the direction with minute precision, we feel the necessity of a precise definition of the terms "storm," and the "centre of the storm." I define the centre of a storm to be the point of greatest barometric depression. The storm of February 16 travelled, then, from sunrise of the sixteenth to sunrise of the seventeenth, five hundred and sixty statute miles in a direction of about north 53° 18′ east, although to sunset of the sixteenth, its direction had been about north 74° 46′ east. It seems probable that its path was not a straight line, although it is possible that its centre, on the morning of the seventeenth, was farther south than I have here assigned, there being a deficiency of observations on the southern quarter. Velocity twenty-three miles per hour. The storm of February 2 and 3, remained nearly stationary. On the fourth and fifth its progress can be pretty accurately traced. It travelled north 62° 17′ east, eight hundred and sixty miles in twenty-four hours, or thirty-six miles per hour. The direction of the storm of December 20, 1836, cannot be precisely assigned. It was clearly eastward, but having only observations from the southern half of the storm, it is impossible to assign, accurately, the place of greatest barometric depression.

CONCLUSION.

The following, then, is my view of the origin of such storms as I have been investigating. This generalization will probably include the greater part of winter storms, but will require some modification when applied to summer storms. Imagine a time perfectly clear, when the wind is from the west, or a few degrees south of west, with the barometer and thermometer at their mean heights. This may be regarded as the normal state of the atmosphere, and the whole body of air from its upper limit to the surface

of the earth is moving on harmoniously in one direction. How is rain produced in such an atmosphere? The first requisite appears to be a change of direction of the lower stratum of air. This appears, in winter, to be frequently the effect of a preceding storm. The prevalent westerly current being temporarily checked in its progress by a violent storm, soon acquires force sufficient to break down all opposition. It supplants the rarefied air of the storm, and not only restores the barometer to its mean height, but the momentum of the excited mass carries it considerably above the mean. This excess of pressure causes a reverse current a little to the westward of a violent storm; and hence we sometimes have a long series of violent storms succeeding each other, at nearly equal intervals; and hence also a violent storm succeeded by an unusually high barometer affords ground for expecting a second storm within one or two days. But this explanation will not apply to all cases, for then, if the barometer should ever settle down to its mean height all over the globe, we never could have another storm. The case here supposed is not likely ever to happen, but even if it should, we cannot admit the consequences attributed to it. Admit such a case to occur, and the sun's heat would be competent to generate a new storm. Different portions of the earth's surface absorb the sun's rays in unequal degrees, and afford unequal quantities of moisture for evaporation. The result is, that we find bodies of air in close proximity of unequal density, arising from unequal temperature or humidity. Either case would be sufficient to cause a deflection of the lower stratum of air from its normal direction. Suppose, then, we have the mass of the atmosphere pursuing its wonted course from west to east, while a stratum of a mile or so in height, next to the earth's surface, blows in some different direction. If this direction be from the south to the north, then this current must be cooled in its progress by change of latitude. This effect may be aided by the inequalities of the earth's surface, and by friction upon the upper stratum of colder air. At the surface of the earth, where the temperature is probably five or ten degrees above the dew point, no remarkable effect may follow. But at a certain elevation, the air is always saturated with vapour. A very slight reduction of temperature causes cloud, and its density and extent will be proportioned to the energy of the causes in operation. If the wind should blow from the north, it might happen that no cloud would be formed; but if the direction should be easterly, being partly opposed to the normal current, some portion of this mass would almost necessarily be elevated from the earth's surface, and being cooled, its vapour be condensed. The first stage of the process, then, is an abnormal current at the earth's surface; the second is the production of cloud. At this stage the sky is covered with a veil which checks radiation; the thermometer rises above the mean from this cause, and also from the heat liberated in the condensation. This only adds to the energy of the first abnormal current. More cloud is thus formed, and presently the particles of water having acquired sufficient size, fall rapidly to the earth. The wind being southerly, the thermometer rises. A portion of the atmosphere being thus unusually heated and loaded with vapour, while the upper limit of the atmosphere remains nearly invariable, the barometer necessarily falls. Thus, these causes might continue to operate a long time, acquiring energy by their own action. A limit, however, is soon attained. The rarefaction thus produced creates a tendency in the surrounding colder and heavier air, to rush in and occupy its place. Moreover, if the wind be at all easterly, as is usually the

case, it partially obstructs the progress of the normal current. This temporary retardation only gives it accumulated energy, and it is soon reinstated with unwonted violence. When the rarefaction is considerable, this rush of air upon the last half of a storm is not generally in the precise direction of the upper current, but more northerly; this air being the denser. Our southerly wind is thus supplanted by a violent north-wester. We have thus a great rarefaction and elevation of the temperature under a south or south-east wind with rain, extending over a large territory. This may be called the third phase of the storm, although it differs from the second only in intensity. There is now a general rush of heavier air to fill this void. This rush is chiefly from the north; but an independent cause, that which imparts direction to the upper current, would give us a west wind. Under these two forces the resulting current is chiefly north-west, but every where upon the borders, the tendency will be inward. The air thus flowing inward towards a central area, forces upwards the warmer air which rises in the middle, and being cooled by elevation, discharges a greater quantity of rain. The currents moving centrally from every point of the compass, interfere with each other, and pursue their routes spirally inward. We have thus a species of rotation, which, in the centre of the storm may have a destructive violence, as at Mayfield, February 4, 1842. This is the fourth phase, and is the case of a violent storm fully organized. This west or north-west wind carries the storm off from a fixed locality, and it is thus transferred successively to points farther and farther east. But this action cannot continue indefinitely. There is a cause in operation which will soon terminate its violence. This westerly wind travels more rapidly than the easterly. The rarefaction at the centre of the storm is a cause which acts equally upon both winds; but the one is opposed to the upper current, and the other nearly coincides with it: hence the one is accelerated, and the other retarded. The result is, that at successive points, farther and farther east, the same storm (after the north-west wind has begun to blow with great violence) has a less duration; the thermometer rises to a less height, the barometer has a smaller oscillation, and thus at a point far eastward, the oscillation becomes nearly extinct, and the only peculiarity observed in the wind is a stronger westerly current succeeding a calm. This is the fifth and final phase of the storm.

It appears to me, that if the course of investigation adopted with respect to the two storms of February, 1842, were systematically pursued, we should soon have some settled principles in meteorology. If we could be furnished with two meteorological charts of the United States, daily, for one year, charts showing the state of the barometer, thermometer, winds, sky, &c., for every part of the country, it would settle for ever the laws of storms. No false theory could stand against such an array of testimony. Such a set of maps would be worth more than all which has been hitherto done in meteorology. Moreover, the subject would be well nigh exhausted. But one year's observation would be needed; the storms of one year are probably but a repetition of those of the preceding. Instead, then, of the guerilla warfare which has been maintained for centuries with indifferent success, although at the expense of great self-devotion on the part of individual chiefs, is it not time to embark in a general meteorological crusade? A well arranged system of

observations spread over the country, would accomplish more in one year, than observations at a few insulated posts, however accurate and complete, continued to the end of time. The United States are favourably situated for such an enterprise. Observations spread over a smaller territory would be inadequate, as they would not show the extent of any large storm. If we take a survey of the entire globe, we shall search in vain for more than one equal area, which could be occupied by the same number of trusty observers. In Europe there is opportunity for a like organization, but with this incumbrance, that it must needs embrace several nations of different languages and governments. The United States, then, afford decidedly the most hopeful field for such an enterprise. Shall we hesitate to embark in it; or shall we grope timidly along, as in former years? There are but few questions of science which can be prosecuted in this country to the same advantage as in Europe. Here is one where the advantage is in our favour. Would it not be wise to devote our main strength to the reduction of this fortress? We need observers spread over the entire country at distances from each other not less than fifty miles. This would require five or six hundred observers for the United States. About half this number of registers are now kept, in one shape or another, and the number, by suitable efforts, might probably be doubled. Supervision is needed to introduce uniformity throughout, and to render some of the registers more complete. Is not such an enterprise worthy of the American Philosophical Society? The general government have, for more than twenty years, done something, and have lately manifested a disposition to do more for this object. If private zeal could be more generally enlisted, the war might soon be ended, and men would cease to ridicule the idea of our being able to predict an approaching storm.

ARTICLE V.

On the Conversion of Benzoïc into Hippuric Acid. By James C. Booth and Martin H. Boyè. Read May 29, 1843.

The importance of the application of chemical principles to the various processes in the animal economy, not less than their interesting character in a scientific point of view, having led us to undertake a few experiments on a singular fact observed some years since by Woehler, we have deemed them worthy of being offered to your notice on the present occasion, although time has failed in completing the series of investigations which was contemplated. I therefore propose to offer you a few remarks on the "Conversion of Benzoic into Hippuric acid," which are the results of the conjoint labours of Professor Booth and myself.

Before entering into the details of the present treatise, it may not be out of the way to make a few remarks on some of the most important ingredients of urine, as far as connected with the present subject; urine contains about ninety-three parts of water and seven of solid substances. Of these seven parts of solid substances, a substance called urea forms three parts. About two parts are formed by inorganic substances, such as chlorides of potassium, sodium and ammonium, sulphates of soda and potassa, and the phosphates of lime, magnesia, soda, and ammonia; while the remaining two parts are mostly formed of other organic substances, as extractive matters, mucus of the bladder, some lactic acid and uric acid.

Urea is in every respect the most remarkable substance in the urine, and that which imparts to it its most peculiar characters. It is a white crystallizable substance, and very soluble in water. It seems to stand on the borders between organic and inorganic substances. It may be produced artificially from inorganic substances, and is itself readily converted into carbonate of ammonia by taking up the elements of one atom of water. It combines with some acids, such as the nitric and oxalic acids, and performs in these compounds the part of a base.

Lithic or uric acid forms only a very small part of the urine; being about one-seventieth of the solid substances, and only one-ten thousandth part of the whole urine. It is very insoluble in water, and this is the reason that it for the most part deposits from urine on cooling. By oxidation it yields, among other products, urea. It forms the greater part of urinary concretions.

The urine of herbivorous animals does not contain any uric acid, but another acid, called hippuric acid, from ἵππος, a horse, in whose urine it was first discovered. It only contains seven per cent. of nitrogen, while uric acid contains thirty-three per cent. By oxidation, it yields, among other products, benzoic acid.

The urine of the horse sometimes contains benzoic acid instead of hippuric. Benzoic acid is generally obtained from gum-benzoin by subjecting it to a gentle heat; when it sublimes in crystalline needles. It will be observed that it contains no nitrogen. It belongs to a series of compounds, which in a historical point of view are of interest, as containing the first well established radical in organic chemistry; that is to say, an imaginary body, which, though never isolated by itself, may be carried through a series of combinations with most of the simple elementary bodies.

The question now naturally arises, how is this transformation of benzoic acid into hippuric effected? We have seen that the normal quantity of uric acid is too small to suffice, if its formation depended on this acid, and, besides, their formation seems independent of each other. That the transformation should be effected in the stomach and intestines during the digestion is less probable: it seems more probable to suppose that it takes place during the subsequent circulation of the blood, and that its formation is connected with that of the urea. We know that at least the principal source of urea is the transformation of the tissues in the body, or what Prout calls the destructive assimilation, since its formation continues, when animals are fed exclusively on non-nitrogenized food, and when they are starved; and that it is not secreted by the kidneys, but actually formed in the body, and merely excreted by them, is proved by removing them, when urea will be found in the blood. The same occurs by suppression of urine. I have myself lately had an opportunity to confirm this observation, in examining, at the request of Drs. Pepper and Sargent, the blood of a patient who for some time previous to her death had a complete suppression of the urine. But the question then is,—is it merely a simple chemical reaction between the benzoic acid and the products of the transformations of the tissues, or does it actually affect the chemical changes, by which the latter are effected, so as to cause new chemical products to be their results. Liebig takes this latter view in his Animal Chemistry. We quote his own words:

"Benzoic acid, when administered internally, appears in the form of hippuric acid. Should the observation be confirmed, it will acquire great physiological significance, since it would plainly prove, that the act of the transformation of the tissues in the animal body under the influence of certain matters taken in the food, assumes a new form with respect to the products, which are its results; for hippuric acid contains the elements of one at. of urea, one of lactic acid, and two of benzoic acid."

Liebig then at once proceeds to make an application of this fact to the action of medicinal agents. We are not disposed to dispute his theories on this point, nor deny that such may be the case in active remedies, but we believe that he is too prompt in drawing the conclusion, that because benzoic acid is converted into hippuric by entering into the system, it should, therefore, necessarily affect the usual chemical changes in the body. We are disposed to consider it as a mere chemical reaction between the benzoic acid and the substances of the blood, either those which are used for the formation of the tissues, or, more probably, those which result from their dissolution. But if this be correct, it fol-

lows, that we may be able to perform the same transformation out of the body. It was with a view of determining this point that our experiments were undertaken, and we still look for success, although they have not hitherto afforded a satisfactory result.

Woehler was the first to observe that benzoic acid, when administered internally to a dog, and again separated from the urine, reappeared as prismatic crystals, unlike benzoic acid; and he conjectured correctly, from their resemblance to hippuric acid, that the former by passing through the system was converted into the latter. He also suggested, that this might be the source of the hippuric acid in the urine of herbivorous animals, since the benzoic acid might be supposed to occur in their food, and by the digestion be converted into hippuric. Ure subsequently stated, that he had found hippuric acid in the urine of a patient who had taken benzoic acid; he also supposed that the uric acid had been employed in this conversion, and recommended it as a remedy for calculous concretions of uric or lithic acid. This induced Keller, at the instigation of Woehler, to make some experiments on this point, which he published in Liebig's Annals of Chemistry and Pharmacy. He took, in the evening before bed-time, two grammes or about thirty-one grains of benzoic acid, and found the next morning, on examining the urine, that by the addition of chlorohydric acid it deposited long prismatic crystals, which it continued to do as long as he continued the use of benzoic acid. By re-dissolving these crystals in hot water and treating them with animal charcoal, he obtained them perfectly colourless. The crystals thus obtained behaved in all respects like pure hippuric acid. They fused easily, and by a stronger heat they charred with a smell of oil of bitter almonds and sublimation of benzoic acid. He also determined the quantity of carbon, which he found to agree with that of hippuric acid, namely, 60.7 per cent., while benzoic acid contains 69.1 per cent. of carbon.

Keller furthermore ascertained that the urine from which hippuric acid had been separated, deposited a large amount of nitrate of urea, on the addition of nitric acid. It had also previously deposited uric acid. It therefore contained these two usual ingredients of urine. He also inferred, that since the urine could be inspissated without depositing hippuric acid before the addition of chlorohydric acid, it was evident that the hippuric acid existed in combination with a base.

As hippuric acid may be said, to a certain extent, to replace uric acid in the herbivorous mammalia, this probably led Ure to the supposition that the uric acid was employed in the conversion of the benzoic acid; but Keller's experiment showed that the urine deposited uric acid, and that therefore this latter assertion could not be correct.

We have repeated Keller's experiments, and with the same results. We have in general found that after the use of benzoic acid the urine makes a copious deposite of uric acid, both in the red or dark-coloured variety and in that of a clay-coloured or muddy appearance.

In one experiment the urine was examined in the morning when no benzoic acid had been taken. It deposited no sediment on cooling, and when tested for uric acid by the addition of nitric acid, the latter effected after twenty-four hours a deposite of only a few isolated colourless crystals scattered over the inside of the vessel. The same day two grammes of benzoic acid were taken immediately after dinner. Twenty minutes afterwards the urine was voided, evaporated to one-fourth its volume, and chlorohydric acid

added. After the lapse of twenty-four hours it had deposited a precipitate of a granular appearance and of a very dark-red nearly black colour, which dissolved with effervescence in nitric acid, and on evaporation yielded the beautiful purple colour of purpuric acid. It therefore consisted of uric acid. Twenty minutes after the first, another portion was obtained, which, treated in the same way, yielded a precipitate in all respects similar to the above. Its quantity also had not diminished; but besides this precipitate there appeared a moderate quantity of needle-shaped crystals of hippuric acid.

These experiments evidently show that the formation of hippuric acid does not diminish the quantity of the uric acid, and that the formation of the former seems entirely independent and disconnected with that of the latter. The urine voided in the morning had a sp. gr. of 1.0112. That voided three or four hours after dinner, and therefore containing most of the hippuric acid, had a sp. gr. of 1.024. Its colour was but slightly more yellow than the former.

Distinction is generally made between the urine secreted after fluids have been taken, especially on an empty stomach, and that secreted subsequently to the digestion of food. The former is much more limpid and tasteless, and contains much less of the solid ingredients. It has been found, that if any substance be taken under the first circumstances, dissolved in the water, it passes much more rapidly into the urine, where some substances have been detected in the short time of from two to ten minutes after their introduction into the stomach; while, when taken with the food, they generally require a much longer time for their reappearance in the urine. In regard to the time which elapses before the benzoic acid reappears as hippuric, it will be seen that in the above experiments it had not yet appeared there in twenty minutes, and that forty minutes after being taken its appearance had but fairly commenced. In another experiment, where the benzoic acid was taken immediately before dinner, a portion of urine, obtained immediately after the meal, and about thirty minutes after the introduction of the acid yielded, when treated as above, an abundant crop of crystals. It was interesting to ascertain how long the hippuric acid would continue to appear in the urine from the time the benzoic acid was taken. In an experiment, where two grammes were taken before and two grammes more immediately after dinner, the urine secreted (from seven to eleven o'clock in the evening or) from four to eight hours after its introduction, contained an abundance of hippuric acid, while none could be detected in the urine voided after that time the next morning.

The quantity of hippuric acid obtained exceeds that of the benzoic acid taken; six grammes taken, two grammes after breakfast, two before and two after dinner yielded in two experiments about eight grammes of crude hippuric acid, or about one-third more than its own weight.

It was a matter of considerable interest to ascertain with what base the hippuric acid occurred combined in the urine, whereby it was held in solution till liberated by an acid. The bases occurring in the urine are potassa, soda, lime, magnesia, and ammonia. Besides these, urea seems in some instances to have a basic nature: thus, in the compounds which it forms with nitric and oxalic acids it evidently acts the part of a base. Cap and Henry have asserted that a portion of it occurs combined with lactic acid in human urine and with hippuric acid in urine of the horse, and they prescribed a method of forming these two compounds by double decomposition of lactate or hippurate of lime and oxalate of

urea, and they also described the methods by which they had extracted the lactate of urea from human urine and the hippurate of urea from the urine of the horse. The former was repeated by Lecanu, who could obtain no lactate of urea. Cap and Henry replied, and gave a new method of obtaining it in crystals by shaking the inspissated urine with a mixture of one volume of alcohol and two volumes of ether, and evaporating the solution by heat over sulphuric acid in a closed vessel. Very recently Pelouze has shown, that neither lactate nor hippurate of urea can be obtained by double decomposition, or in any other way, and that they therefore do not exist, and that Cap and Henry had nothing but urea, which had imbibed the acids.

If hippurate of urea therefore existed, it would not be improbable that this acid might occur combined with urea in the urine, and in our experiments particular attention was paid to this point. The urine was evaporated, filtered, and further evaporated in a water-bath to a thick syrup, and then left at rest for several weeks, in the hope that the combination of hippuric acid would crystallize. A quantity of crystals appeared, which, being well drained from the mother-liquid, were found to contain no hippuric acid. They consisted chiefly of chlorides of ammonium and sodium, with the phosphates of the same bases. The mother-liquid, on the contrary, formed nearly a solid mass when tested for hippuric acid by the addition of chlorohydric acid. By adding more water, and straining the mother-liquid from the crystals, subsequent addition of nitric acid caused an abundant precipitate of nitrate of urea. The main mass of the syrup was now shaken for several days in a closed bottle with a mixture of one volume of alcohol and two volumes of ether, which were decanted and evaporated by heat over sulphuric acid. While concentrating, it yielded prismatic crystals, and finally the whole was converted into a mass of crystals with but little mother-syrup. The crystals were carefully dried between blotting paper. They were, therefore, obtained according to Cap and Henry's directions for extracting the lactate of urea; but they proved to be pure urea, so that unless the lactic acid has been employed in the formation of hippuric acid, lactate of urea is not obtained in this way, and at all events it shows that urea is also dissolved by this process. The same process of extraction was repeated with a fresh portion of the same mixture, and with the same results; but the evaporation was not carried so far, in order to be able to examine the mother-liquid. We obtained a crop of crystals of pure urea, containing no hippuric acid, while the mother-liquid had a bitterish taste but did not yield hippuric acid by the addition of chlorohydric acid. It was therefore evident that the above mixture extracted pure urea, while it left behind the combination of hippuric acid. We next employed a mixture of equal volumes of alcohol and ether, which dissolved a much larger quantity from the original syrup, but on evaporation yielded only a slight crop of crystals. The greater part of it remained as a thick syrup, yielding an abundance of crystals of hippuric acid by the addition of chlorohydric acid, but also a large amount of nitrate of urea by the subsequent addition of nitric acid. It was therefore evident that the compound of hippuric acid was also extracted by the last treatment, and it merely remained to find the base. A few drops of the syrups charred and incinerated, left no residue, proving the absence of all the fixed bases of the urine. The hippuric acid could therefore only be combined with urea or ammonia, to ascertain which chlorohydric acid was added to a portion of it, and after the separation of the hippuric acid, chloride of platinum added, which caused a very copious

precipitate of chloroplatinate of ammonium. The addition of nitrate of silver and nitric acid to the liquid proved it to contain a certain amount of chlorine as chloride of ammonium, but much less than would be able to yield a precipitate so copious as the above. We, therefore, continued the extraction by fresh portions of equal volumes of alcohol and ether, and thus succeeded in obtaining a solution that yielded by evaporation a viscid mass, which, by addition of chlorohydric acid, gave an abundance of hippuric acid, and by subsequent addition of chloride of platinum a corresponding copious precipitate of chloroplatinate of ammonium; but on the addition of nitric acid it yielded no nitrate of urea nor any trace of this substance by evaporation, but only copious crystals of chloride of ammonium. It was thus made evident that urea is not combined with the hippuric acid, but that the base which retains it in solution and with which it is combined is ammonia. It also confirms the assertion of Pelouze that hippurate of urea does not exist.

The results of the foregoing experiments may be summed up thus.

1. The formation of uric acid in healthy urine is not affected either in regard to its quantity nor to its external properties in general by the introduction and transformation of benzoic acid into hippuric acid in the system.

2. The time required for the benzoic acid to pass through the system, and reappear as hippuric in the urine, is from twenty to forty minutes after its introduction with food into the stomach. Its occurrence continues for four or eight hours, but then ceases.

3. The quantity of hippuric acid obtained from the urine is greater than that of the benzoic acid taken. In round numbers it may be stated to be one-third more.

4. Urea is not in combination with the hippuric acid in the urine.

5. The base with which the hippuric acid is combined, and which keeps it in solution, is ammonia.

ARTICLE VI.

Account of the Observatory and Instruments of the United States Military Academy at West Point; with Observations on the Comet of 1843. *By Prof. William H. C. Bartlett. Read May* 30, 1843.

I HAVE been honoured by the receipt of an invitation to attend the celebration of the one hundredth anniversary of the organization of the American Philosophical Society, at Philadelphia, accompanied by a request from the Committee, to prepare a paper giving an account of the "Observatory and Instruments of the Military Academy," and "Observations on the Comet of 1843."

It will be out of my power to attend, personally, the meeting; and I prepare the paper referred to, more to indicate a desire to contribute to the interest of the occasion, than with any hope that what I have to offer will have this effect.

I ought, in the beginning, to remove a misapprehension under which the Committee seem to be, in regard to the objects of the new building at this place, which is, not unfrequently, called an "Observatory." We have aimed at nothing more in its erection than to provide suitable accommodation for the library of the academy, philosophical apparatus, and such astronomical instruments as were deemed indispensable to illustrate practically our course of astronomy. It supplies the place of one which was, a few years since, destroyed by fire.

It is built principally of granite, taken from the side of the neighbouring mountain, and stands at the south-east angle of the plane of our table land, about one hundred and sixty feet above the level of the river, having an uninterrupted view to the south of about eight miles, and to the north of about four. Fig. *M* represents a perspective view taken from a point about one hundred and fifty yards to the south-west, and Fig. *N* a similar view from a point equally distant to the north-east.* Fig. *P*, Pl. 28, is a horizontal section, midway between the water table and eaves. Fig. *Q*, Pl. 29, is a vertical section parallel to the north front, taken on the broken line AB, CD, EF; and Fig. *R*, Pl. 30, a vertical section perpendicular to this latter front through the centre tower (3.)

The main cell covers a space of one hundred and twenty by sixty feet, and is divided into two equal parts by a partition wall in the plane of the last named section. The

* It has not been thought necessary that plates of these perspective views should accompany the printed paper.

western division (1), with the towers (3), (4), (5), is appropriated to the department of natural and experimental philosophy for purposes of instruction; and the eastern (2) which is in one entire room from the water table to the top of the cell, to the library. The first division has two floors, on the lower of which are the recitation rooms, and on the upper a lecture room in which is the entire apparatus, with the exception of the astronomical instruments. These are in towers prepared expressly for them.

Within the towers, as will be seen by the sections, are masses of masonry, which rise from a bed of coarse gravel at a level twelve feet below the natural surface of the ground, to a height necessary to free the view from all obstruction by neighbouring obstacles. These walls are insulated from those around them, as well as from the floors, stair-ways and ceiling; and are pierced by large openings at different levels to secure a free circulation of air. Immediately to the south of the central tower, is a fourth insulated column (6), Fig. *P*, which terminates on a level near the ridge of the roof, above which the masonry of the enclosing wall is carried about five feet, where it terminates in a kind of parapet; thus forming an open space (7), Fig. *R*, for gazing observations, while the students are occupied in the use of the portable instruments, such as the smaller telescopes, repeating circle, altitude and azimuth instrument, sextant, &c. Access to this place is from the central tower, within which is a small room (9), for the safe keeping of the instruments just named. The mountain to the north may be seen through the door of communication, and an aperture in the column (10), and external wall (11), of the middle tower; thus securing to this position a distant meridian mark to the north as well as to the south. The central tower is surmounted by a travelling dome twenty-seven feet in horizontal diameter, and about seventeen feet high from the spring; and the surface is of a shape which would be generated by the rotation of a circular arc, about a vertical chord somewhat less than the diameter. It is pierced by five window openings near the curb, and an observing slit, two feet wide, extending from a point forty-eight inches above the floor to nearly two feet on the opposite side of the zenith. This last opening is furnished with a range of shutters of nearly equal length which are worked by means of levers and cords independently of each other. The whole dome rests on six twenty-four pound cannon balls, which turn between two cast iron annular grooves, one of which is inverted and attached to the curb piece, and the other to the cell walls of the tower. Motion is communicated to the dome by means of a rack attached to its base, and a stationary pinion, which is turned by a hand-wheel, seven feet in diameter.

Meridian observing slits are made in the flank towers, about twenty inches in the clear. These begin about two feet and a half from the floor and extend through the roof, thus affording an uninterrupted view of the celestial meridian from the southern to the northern point of the horizon. The design and architectural composition of the building, which is of the Elizabethan style of Gothic, and the effect of which is considered very good, is due to Major Delafield, the Superintendent of the institution.

THE EQUATORIAL.

The only fixed instrument in place, is in the central tower. It is an equatorial by Mr. Thomas Grubb, of Dublin, which is believed to possess some merit. Its object is to measure by direct observation the apparent declination and hour angle of any heavenly body. By means of the latter and the sidereal time of observation, the apparent right ascension, which is equal to their sum, becomes known. The instrument consists, essentially, of two axes of motion at right angles to each other, two graduated circles, one attached to each axis at right angles to its length, and a supporting frame. When the instrument is adjusted for use, one axis is parallel to that of the earth, and the other to the plane of the equator, the former being called the polar and the latter the declination axis.

In principle, Mr. Grubb's instrument resembles that of Fraunhofer. In the arrangement of its parts, it is, however, different, and very simple. Fig. *S* represents a perspective view of this instrument taken from a point to its north-east, the telescope being in the meridian. Fig. *T* exhibits a meridian section, the declination axis being in this plane, and the telescope directed to the pole. The polar axis, (1) Fig. *T*, is about forty inches long between the bearings, is of a conical shape, terminating towards the vertex in a well turned steel pivot about three-eighths of an inch in diameter, and at its base in an accurately turned cylinder, one inch in length, and about eight inches in diameter. It is hollow for a distance of more than three-fourths of its length from the larger end, and is mounted in the centre of two acute hollow conic frustrums (2), (3), which are united to each other by screw-bolts, as represented at (4), so as to have a common axis. The diameter of the largest base is twenty-two inches, and that of the smallest ten and a half. Connected with a flanch (9), at the largest base, are two substantial pieces of wrought iron (5), united in a crucial form at right angles to each other, and perforated at the place of union, which is in the common axis of the frustrums. This perforation receives a cylindrical box of iron with a large bearing head (6), and this latter a solid cylindrical piece of Brazilian metal, terminating at one end in a bearing head (7), in which is a small cavity for the reception of the lower end of the polar axis, and at the other in a screw for a nut, which keeps it in place. This latter cylindrical piece is smaller than the opening through the box (6), and may be moved laterally by means of four small screws (8), which enter the box at right angles to each other. By this device, the more delicate adjustments of the polar axis are made. The collar, or upper bearing surface of the polar axis, rests upon two pieces of Brazilian metal (10), Fig. *C*. which are let into the inner surface of the smaller conic frustrum, at its smaller base. These pieces are about three quarters by one inch on the rubbing surface, and of a proper shape to receive the cylindrical form of the axis. They are 90° apart, each being 45° from the meridian; and are relieved from a great portion of the pressure, by a friction roller (11). The polar axis has, at the larger end, a square flanch, projecting outward so as to measure eight and a half inches on a side; the edge of this flanch is seen at (15), Fig. *S*, and to its lower surface, the hour circle (13) is attached. The hour circle is of brass, and in shape resembles, when in place, an inverted shallow cylindrical cup, with a circular hole in its base just large enough to receive the polar axis. The graduation is on a band of

silver sunk into its outer surface, which is twelve inches in diameter, and reads, by the aid of three verniers, to a second of time.

Upon the square flanch, at the top of the polar axis, rests a cast iron frame for supporting the declination axis. It consists of a cubical base eight and a half inches on the edge, perforated on opposite faces with which are united at their larger bases two short hollow conic frustrums (16). Attached to one end of this frame is a circular flanch (17), fifteen inches in diameter, with a channel in its circumference to receive a friction hoop for the tangent screw (22), Fig. *S*, of the telescope and declination circle. Two pieces of Brazilian metal, similar to those shown in Fig. *C*, are let into the concave surface of the opening in this circular flanch, and serve as Y bearings for one end of the declination axis. The other end of the frame terminates in a short flanch against which is supported, by strong screws, a circular plate (19), of Brazilian metal. This plate has a circular apperture large enough to receive freely the declination axis; and to secure the proper bearing points, the lower edge of the aperture is cut away, as shown at (20), Fig. *D*, thus converting the circular into a Y bearing for the other end of the axis. The screw holes in this plate are of an oblong shape, to admit of a motion in the plate itself in the direction of the polar axis. This motion is communicated by means of a device, shown at (21). By this, the declination axis is adjusted.

This axis (23) is represented out of its bearings, because the section is made where they are not found. One end of this axis has a strong square flanch eight inches on a side, and to this the cradle of the telescope is attached by strong screw bolts, of which the head of one is seen at (26), Fig. *S*. The diameter of this axis at the bearing surface nearest the telescope is four inches, and at the other, a little more than three. About three-fourths of an inch from the bearing plate (19), the axis is contracted to form a shoulder to receive the declination circle (24), which is secured by two strong steel screws; and beyond this, the axis projects about eleven inches to receive the counterpoise weights (27). To prevent all motion in this axis in the direction of its length, a steel roller (34), about one inch in diameter, and twenty-eight inches long, is held in the centre of the polar axis by two perforated steel bars (35), (36), which are firmly attached to the polar axis, and within which the roller turns with the utmost freedom, but without play. At the upper end of the roller is a circular head, whose diameter is just equal to the width of an annular groove in the declination axis within which it works. The axis is pressed into its bearings by a friction wheel which enters the cubical box at the top, and is secured in its place by a stiff frame and screw (29); and the whole frame is securely attached to the head of the polar axis by strong screw bolts (30), represented in dotted lines.

The declination circle (24), which is fifteen inches in diameter, is also of brass, and the graduation is on a band of silver sunk into its outer rim. It has two verniers (32), 180° apart, by which the smallest count is fifteen seconds of space, and two reading micrometers (31), by which the smallest count is reduced to one second.

The clock-work is represented at (37), Fig. *S*. It is put in communication with the instrument by means of a circular sector (38), whose centre of curvature is in the polar axis, and whose circumference is provided with teeth that work into an endless screw, of which the axis is seen at (48). To the arm (40) of this sector, one of the nuts (41) of the

tangent screw of the hour circle is attached. The arrangement of the tangent screw is shown at (39) in Fig. *T*. In this figure (44) is a circular plate, seventeen inches in diameter, with an aperture in the centre large enough to receive the polar axis, to which it is firmly attached by a key bolt (43). In the circumference of this circle is a groove which receives the friction band with its clamp screw (42), and to this band is attached the arm (46) which carries the nut of the tangent screw (39). Against the upper surface of this circle, the sectoreal arm (40), represented in Fig. *E*, is held by a small truncated conical plate (45) Fig. *T*, which fits into a chamfered aperture (47) in the arm, and is securely attached by screws to the clamp circle. When the circle is clamped, and the teeth of the sector in gear, the hour circle can move only with the clock, or by the turns of the tangent screw; but when unclamped, the hour circle is moved freely by the hand applied to the telescope, while the sector is in connexion with the clock; and the instant the hand is removed, the hour circle takes up the clock movement, in consequence of the friction between the surface of the clamp circle and sector. This device is very convenient, as it saves the labour and time of unclamping and clamping in transferring the telescope from one object to another. The axis (48), Fig. *S*, of the endless screw, passes through a circular aperture in the centre of the wheel (49), and the arrangement is such, that by means of a small pin, the wheel and axis may be firmly united or rendered independent of each other, so that when the sector is exhausted by the motion of the clock, it is renewed by throwing the wheel out of gear with the axis, and reversing with the hand, by means of a winch-key, the motion of the endless screw.

The rate of the clock is regulated by a centrifugal governor, the balls of which are attached to the ends of a horizontal piece, at the top of the axis of motion, and when at rest are supported by a second cross piece (51). Connected with the supporting rods of the balls, are two brass arms that carry each a small box-wood screw (52), whose axis is perpendicular to a horizontal friction plate (53), with which they are brought in contact by the recession of the balls from the axis during the motion. By unscrewing these, the rotation is accelerated,—by screwing them up, retarded. The whole instrument is placed upon a solid block of granite, of the shape shown in Figs. *S* and *T*, to which it is attached by heavy screw bolts sunk into the inclined surface (60), which is parallel to the equator, and secured by molten sulphur. The surface (61) is horizontal.

The telescope, by Lerebours of Paris, is a refractor whose solar focal distance is eight feet and aperture six inches. It has a fine position micrometer (56), furnished with an illuminating apparatus for bright lines and dark field, the lines being illuminated on both sides. The diameter of the position circle is inches; the graduation is on a silver band, and reads by the aid of two verniers as low as thirty seconds. The micrometer is also by Grubb. (57) is a small finder, and (58) a mass of lead attached to the cradle to counterpoise the telescope.

ADJUSTMENTS.

The stone block upon which the instrument rests having been carefully cut to a frame prepared for the stone-cutter, was put in place by the aid of a small theodolite, whose axis of collimation was carefully adjusted by Polaris to the meridian. A well defined

black line was drawn upon the equatorial and horizontal surface of the stone, perpendicular to the line of intersection of these surfaces at its middle point, and the latter surface being kept horizontal by means of a large spirit level, the stone was moved till the traces were brought into the meridian, as indicated by a sweep of the telescope of the theodolite. The instrument was then put up.

The following conditions must be fulfilled by an equatorial in perfect adjustment.

1. The polar axis must be parallel to that of the heavens.

2. The declination axis must be parallel to the equator, or perpendicular to the polar axis.

3. The line of collimation of the telescope must be perpendicular to the declination axis.

4. The index of the declination circle must point to zero, when the line of collimation is parallel to the equator.

5. The index of the hour circle must point to zero, when the line of collimation is in the meridian of the place.

M. Littrow has given in the Mem. of the Ast. Soc. Vol. II. part I. p. 45, formulæ for the determination of the true apparent place of a heavenly body from the place as indicated by an equatorial out of adjustment. These were improved by M. Kriel, Mem. of the Ast. Soc. Vol. IV., p. 495. The adjustments have been made by these formulæ, which are

$$s=\sigma+\Delta\sigma+\lambda.\ \sin(\phi-s).\ \tan\delta+\mu\tan\delta+\nu\sec.\delta\ .\ .\ (1)$$
$$p=\pi+\Delta\pi+\lambda.\ \cos(\phi-s).\ .\ .\ .

whence we obtain, by taking the second from the first,

$$\Delta\pi=\frac{\pi-\pi'}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

by which the verniers were corrected.

THE LINE OF COLLIMATION.

The declination circle was placed at zero, after correcting the verniers, (the instrument reads declinations,) and the telescope directed to some distant point to the east or west, in the direct and reversed position of the instrument. In equation (1), we had

$$\delta=0;$$

and because the graduation of the hour circle is numbered from 0° to 360°, or from 0 to 24^h.

$$s=\sigma+\Delta\sigma+\nu,$$
$$s=\sigma'+\Delta\sigma-\nu;$$

subtracting the second from the first we get

$$\nu=\frac{\sigma-\sigma'}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This error was applied with its proper sign to the last reading, to which the instrument was then set, and the line of collimation brought to bear on the object by the screws which attach the cradle to the declination axis.

THE DECLINATION AXIS PERPENDICULAR TO THE POLE.

The telescope was directed to a point directly north or south, to get the greatest declination, in the direct and reverse position; and because by the last adjustment, $\nu=0$, equation (1) gave

$$s=\sigma+\Delta\sigma+\lambda.\ \sin\ (\phi-s).\ \tan\ \delta+\mu.\ \tan\ \delta.$$
$$s=\sigma'+\Delta\sigma+\lambda.\ \sin\ (\phi-s).\ \tan\ \delta-\mu.\ \tan\ \delta.$$

Taking the difference and reducing, we had

$$\mu=\frac{\sigma-\sigma'}{2\ \tan\ \delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Setting the instrument to the last reading corrected by $\frac{\sigma-\sigma'}{2}$, the line of collimation was brought back to the object by the adjusting screw (21), connected with one end of the declination axis.

THE POLAR AXIS OF THE INSTRUMENT PARALLEL TO THAT OF THE HEAVENS.

A well known star was observed in quick succession on the meridian, in the direct and reversed position of the instrument. The declination reading, corrected for refraction, gave in equation (2)

$$p=\pi+\Delta\pi+\lambda.\cos\phi,$$
$$p=\pi'-\Delta\pi+\lambda.\cos\phi;$$

whence

$$\lambda\cos\phi=p-\frac{\pi+\pi'}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The first member, being the projection of the arc λ on the meridian, is the arc by which the pole of the instrument is too high or too low. The foot of the polar axis being moved through this distance by estimation, the declination circle was then set to the declination, corrected for refraction, of a second star soon to come to the meridian, and the telescope directed to it, the clock put in motion, and as the star culminated, as indicated by a chronometer, the adjusting screws (8), which are in the meridian at the foot of the polar axis, were turned till the line of collimation was brought to the star.

Another star was observed in quick succession in the direct and reverse position of the instrument, when six hours to the east or west of the meridian, in which case

$$s=90°,$$

and formula (2) gave

$$p=\pi+\Delta\pi+\lambda.\sin\phi,$$
$$p=\pi'-\Delta\pi+\lambda.\sin\phi;$$

whence

$$\lambda.\sin\phi=p-\frac{\pi+\pi'}{2}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

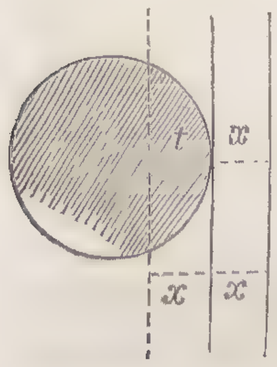
the first member, being the projection of the arc λ on a declination circle at right angles to the meridian, is the displacement of the pole of the instrument from this latter plane, and was hence known. This error being treated in manner similar to the preceding by the screws (8) which are perpendicular to the meridian, the adjustment of the polar axis was completed.

The instrument when first put together being very much out of adjustment, terrestrial objects, as already remarked, were taken as being more convenient for the first approximations. Celestial objects in similar positions were afterwards used for all subsequent ones.

VALUE OF THE MICROMETER REVOLUTION.

This was obtained by the usual process of taking the transits of stars near the equator and the distances of well known double stars. But the process which gave results agreeing with each other as well as any, is one which occurred to me while observing

the solar spots; and as I have not met with it before, I have thought it would not be out of place to give it here.



Let s denote the apparent diameter of the sun in seconds of space, x the apparent distance between the parallel wires of the micrometer expressed in the same unit, t the time of the sun's diameter passing each wire, supposed perpendicular to the equator, and t' the time required for the same limb to pass from one wire to the other. Then assuming that the motion of the sun in right ascension is uniform during the transit over each wire, will

$$s : x :: t : t';$$

$$x = s.\frac{t'}{t};$$

whence calling v the value of one division on the screw head, and n the number of these divisions which mark the separation of the wires, we have

$$v = \frac{x}{n} = \frac{s}{n}.\frac{t'}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

EXAMPLE.

March 24th, 1843.

1st Limb.	11h	25m	40s.5 . . . (1)	A	1st Limb.	11h	32m	12s. . . . (1)	B
	11	26	34. . . . (2)			11	33	04.5 . . . (2)	
2d Limb.	11	27	54. . . . (1)′		2d Limb.	11	34	24.5 . . . (1)′	
	11	28	42.5 . . . (2)′			11	35	13. . . . (2)′	

A $\begin{cases} (1)'-(1) = 2^m\ 13^s.5 \\ (2)'-(2) = 2\ \ 08\ .5 \end{cases}$

B $\begin{cases} (1)'-(1) = 2^m\ 12^s.5 \\ (2)'-(2) = 2\ \ 08\ .5 \end{cases}$

$$4)\ 8\ \ 43 = 2^m\ 10^s.75 = 130^s.75 = t.$$

A $\begin{cases} (2)\ -(1)\ = 53^s.5 \\ (2)'-(1)' = 48\ .5 \end{cases}$

B $\begin{cases} (2)\ -(1)\ = 52^s.5 \\ (2)'-(1)' = 48\ .5 \end{cases}$

$$4)\ 203 = 50^s.75 = t'.$$

From Naut. Alm. $s = 1925''.68$.

The wires were separated by a distance of ten revolutions in each screw, and the heads having one hundred divisions each,

$$n = 2000.$$

These values substituted in eq. (8) give

$$\nu = \frac{1925''.68}{2000} \times \frac{50^s.75}{130^s.75} = 0''.37367.$$

THE COMET OF 1843.

The instrument just described was hardly in working condition, before the announcement of a comet within our system gave hopes of a speedy opportunity to test its qualities.

The weather was unfavourable till the 24th of March, when the first observations upon the new visiter were made; the last were on the 2d of April. Of the intermediate days, the only ones admitting of observation were the 25th and 29th of March. I have taken those of 25th and 29th of March, and of 2d April, to compute the elements of the orbit.

The observations were commenced by the usual simple and accurate method of measuring differences of right ascension and declination of the comet, and certain small stars, which were in the field at the same time; but recollecting that I had no catalogue more extensive than that of the Royal Astron. Society, in which the stars in question could not be found, I was obliged to have recourse to another method.

It is obvious that *the difference of the instrumental places of two bodies, corrected for the change of instrumental errors arising from a change of position, is equal to the difference of their true places.* This corrected difference may be found from Kriel's formulæ (1) and (2), as soon as λ, ϕ, μ and ν are known. If then, some well known star be observed on the same evening with the comet, the true place of the latter becomes known, since that of the former is obtained from the catalogue, and the quantity by which it differs from the place of the comet, by observation. To keep the instrument as nearly as possible in the same bearings during the observations on both bodies, α *ceti*, in the neighbourhood of the comet, was selected and used throughout.

TO FIND ϕ AND λ.

The co-ordinates of a known star, corrected for refraction, when on the meridian, and six hours to the east or west, being substituted in equations (6) and (7), we obtain by squaring, adding, and taking square root,

$$\lambda = \pm \sqrt{\left(p_{,} - \frac{\pi_{,} + \pi_{,,}}{2}\right)^2 + \left(p' - \frac{\pi' + \pi''}{2}\right)^2} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and dividing eq. (7) by eq. (6)

$$\text{Tan } \phi = \frac{p' - \frac{\pi' + \pi''}{2}}{p_{,} - \frac{\pi_{,} + \pi_{,,}}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

TO FIND μ AND ν.

Denote by $\mathcal{A}$R, the right ascension of a star, and by t' the sidereal time of observation, then will

$$s = t' - \mathcal{A}\text{R.},$$

and eq. (1), for the same star observed in quick succession in direct and reversed position, gives

$$s = (t' - \mathcal{A}\text{R}) = \sigma' + d\sigma + \chi \sin(\phi - s) \tan \delta' + \mu \tan \delta' + \nu \sec \delta'.$$
$$s' = (t'' - \mathcal{A}\text{R}) = \sigma'' + d\sigma + \lambda \sin(\phi - s) \tan \delta' - \mu \tan \delta' - \nu \sec \delta'.$$

Taking the first from the second and reducing, we have

$$(t'' - t') - (\sigma'' - \sigma') = -2\mu \tan \delta' - 2\nu \sec \delta'. \quad . \quad . \quad . \quad . \quad . \quad (11)$$

and for a second star differing considerably from the first in declination,

$$(t_{,,} - t_{,}) - (\sigma_{,,} - \sigma_{,}) = -2\mu \tan \delta'' - 2\nu \sec \delta''. \quad . \quad . \quad . \quad . \quad . \quad (12)$$

in which μ and ν are the only unknown quantities.

EXAMPLE.

To illustrate, I take the stars observed on the 3d of April.

Object.	Face	Time by Chronometer.	Chrono. Interval.	Sidereal Interval.	Hour Circle.	Hour Circle Interval.	Dec. Circle.	Refr.	Instrumental Declination.	Naut. Alm. True Declination.
				$(t_{,} - t)$		$(\sigma' - \sigma)$				
γ Ursæ Majoris.	N.	$4^h41^m42^s$.	8^m00^s.	$8^m01^s.31$	$5^h56^m16^s$.	8^m05^s.	54°33′45″.	−40″.89	54°33′04″.1	54°33′52″.48
	S.	4 49 42.			18 04 21.		54 33 45.			
ε Hydræ.	W.	7 35 01 .5	6 26.	6 27 .05	17 57 10.	6 38.	7 01 00.	−39 .89	7 00 35 .1	6 59 16 .3
	E.	7 41 27 .5			6 03 48.		7 01 30.			
θ Ursæ Majoris.	E.	8 18 14.	10 26.	10 27 .7	5 56 51.	10 12.	52 24 30.	11 .35	52 24 23 .5	52 23 18 .3
	W.	8 28 40.			18 07 03.		52 23 55.			

The data furnished by this table in equations (9) and (10), give

$$\lambda = \sqrt{(48.4)^2 + (72)^2} = 86''.75 = 1'26''.75.$$

$$\text{Tan } \phi = \frac{48.4}{72} = \text{Tan } 33°54'35''.$$

$$\phi = 33°54'35''.$$

and in equations (11), (12), give, regarding face west as the reversed position,

$$0.24\,\mu + 2.02\,\nu = -11^s$$
$$2.60\,\mu + 3.28\,\nu = -15^s$$

whence

$$\nu = -5^s.56. \quad . \quad . \quad . \quad . \quad . \quad \text{Face E.}$$
$$\mu = 0^s.95. \quad . \quad . \quad . \quad . \quad . \quad \text{Face E.}$$

These values being substituted in equations (1) and (2), the Comet was wrought out as in the following example for the 29th of March.

Data from observation.

Date	Object,	Sid. Time	Hour Circle	Dec. Circle
1843,	α ceti	$8^h\ 00^m\ 16^s.8$	$5^h\ 06^m\ 18^s.$	$3°\ 36'\ 15''.$
March 29th.	Comet.	8 31 27 .4	4 36 28.	-6 40 15 .

Columns fourth and fifth were corrected for refraction by the following formulæ, the thermometer and barometer indicating about mean refraction, namely,

$$\text{Refr. in } \text{Æ} = 57'' \frac{\text{Tan } s. \sin \psi}{\text{Cos } \delta. \sin (\psi + \delta)}$$

$$\text{Refr. in Dec.} = 57''. \cot (\psi + \delta).$$

$$\text{Tan } \psi = \cos s. \cot L.$$

In which L is the latitude of the place, being in this instance, $41°\ 23'\ 31''$; and s the hour angle of the instrument; the values of σ and π, for both bodies are therefore known; and employing σ for s in equation (1) we have for

α ceti	$\sigma =$	$5^h\ 06^m\ 30^s.9$	
$\lambda \sin (\phi - s) \tan \delta$	$=$	$-0\ 00\ 00.24$	
$\mu \tan \delta$	$=$	$-0\ 00\ 00.16$	
$\nu \sec \delta$ . . .	$=$	$0\ 00\ 07.56$	
	$s =$	$5^h\ 06^m\ 38^s.16$	

comet	$\sigma =$	$4^h\ 36^m\ 41^s.01$
$\lambda \sin (\phi - s)$, tan .	$\delta =$	$0\ 00\ 00.39$
$\mu \tan \delta$	$=$	$0\ 00\ 00.11$
$\gamma \sec \delta$	$=$	$0\ 00\ 06.81$
	$s' =$	$4^h\ 36^m\ 48^s.31$

whence

$$s' - s = 23^h\ 30^m\ 10^s.15 = t' - t + \text{Æ} - \text{Æ}'.$$
$$0\ 31\ 10.60 = t' - t.$$
$$22^h\ 58^m\ 59^s.55 = \text{Æ} - \text{Æ}'.$$
$$\text{Naut. Almanac, . . . } 2\ 54\ 05.40 = \text{true Æ of a ceti.}$$
$$3^h\ 55^m\ 05^s.85 = \text{true Æ' of comet.}$$

And from equation (2) we have for

α ceti, π . . .	$=$	$86°\ 26'\ 36''.7$	
$\lambda . \cos (\phi - s)$.	$=$	$0\ 01\ 03\ .72$	
		$86°\ 27'\ 40''.42$	

comet π'	$=$	$96°\ 43'\ 42''.70$
$\lambda . \cos (\phi - s)$ . .	$=$	$0\ 01\ 10\ .82$
		$96°\ 44'\ 53''.52$

whence,

$$\pi' - \pi = 10°\ 17'\ 13''.10,$$
$$P = 86\ 31\ 45\ . \quad \text{true polar dist. of } \alpha \text{ ceti.}$$
$$96°\ 48'\ 58''.10 \text{ true polar dist. of comet.}$$
$$\delta = -\ 6\ 48\ 58\ .10 \text{ true declination of comet.}$$

In this way the following places were obtained for the comet.

March 25,	. .	Æ . .	$3^h\ 35^m\ 20^s.14$;	Dec.	$-7°\ 48'\ 46''.6 = \delta.$
" 29,	. .	" . .	3 55 05.8;	"	$-6\ 48\ 58 = \delta.$
April 2,	. .	" . .	4 11 51.95;	"	$-5\ 58\ 43\ .1 = \delta.$

which being converted into longitudes and latitudes, and cleared from the effects of aberration by the usual formulæ for a fixed star, gave

March 25,	longitude	49° 17′ 52″;	latitude . .	$-26°\ 18'\ 11''$.
" 29,	"	54 52 35 ;	" . .	$-26\ 32\ 35''$.
April 2,	"	59 37 38 ;	" . .	$-26\ 37\ 42$.

The portion of the aberration due to the proper motion of the comet was applied to the time, according to the method of M. Gauss. The correction in the place of the earth for the effect of parallax, was disregarded in consequence of its small value, the first curtate distance being greater than unity.

The method by which the following elements were computed was that of Dr. Olbers, as given by Dr. Bowditch in the appendix to his commentary on the "*Mecanique Celeste.*"

Longitude of the ascending node . . .	357° 41′ 49″.
Inclination, ...	36 41 48 .
Longitude perihelion, ...	261 31 47 .
Perihelion distance, ...	0.053774.
Perihelion passage, Greenwich mean time, February, .	26^d. 6018.

Motion Retrograde.—Distance from the earth on the evening of
29th March, ... 107,002,000 miles.

Approximate diameter of the nebulous envelope, ... 36,800.

I am indebted to Prof. Church for having kindly undertaken an independent computation of the elements as a check upon my own, and for having assisted with Lieutenant Roberts in making the observations. The perspective views are by Lieutenant Richard Smith, and the sections of the building by Lieutenant Eaton.

WM. H. C. BARTLETT:

ARTICLE VII.

Memoir on the Character and Prospects of the Copper Region of Gibara, and a Sketch of the Geology of the north-east part of the Island of Cuba, by Rich. C. Taylor. Read May 30, 1843.

The writer of the following pages passed a portion of the year 1836 in investigating the Gibara and Holguin Mineral Region, a district, which, prior to that period, was little known to science. Some of his notes relative to Cuba geology, in the form of detached papers, were contributed to the London and Edinburgh Philosophical Magazine; and to Loudon's Magazine of Natural History: and the American Philosophical Society has done him the honour to print in one of their volumes of Transactions, an account of the deposites or veins of mineral pitch or bitumen, denominated *Chappapote*, in the neighbourhood of Havana and Matanzas, and also in the Bay of Havana.

Many details of the geology around Gibara, and in particular those relating to the mineral and savana region south of that port, were reserved for a more elaborate communication, and for some such favourable occasion as the present.

The main difficulty, which at the outset seemed to render the undertaking almost impracticable, was the total absence of a topographical map: nor was it found possible to remedy the deficiency, on the occasion, save by one means—to construct a map for himself, sufficient for geological illustration. With the aid of the few instruments then in his possession, he commenced the framework of his topographical survey, and made the essential observations alone and almost entirely unassisted.

These notes have now, after a long interval, been put together. Upward of a hundred lines and angles of intersection, and considerably more than that number of topographical admeasurements, form the basis of the accompanying reconnoissance. The writer was compelled to abandon the work and to return home, before requiring a sufficient number of points, essential to an adequate triangulation of the area examined. For this there is now no remedy; and he proceeds to make the most of the materials he has acquired. Those who have experienced the toil of such investigations within the tropics; the exposure to enervating heat; and have felt the fatigue consequent on any exertion in the midst of a tropical mountain vegetation,—and that single handed,—will be ready to make all reasonable allowance for the obvious deficiencies of the present communication. All that he

assumes, therefore, in its behalf, is that it suffices for the outline of a geological reconnoissance; that it exhibits sufficiently the position of the most remarkable mountain masses; and that it illustrates the localities of the rock formations, and the direction of the mineral veins within the area submitted to examination.

Of late years, enterprise, at home and abroad, has unfortunately received so severe a check, that no progress has been made in cultivating the really valuable mineral resources of this part of the Island. They remain, therefore, pretty nearly in the state in which they were left by the writer, a few years ago. It is not improbable but that a faithful sketch of what fell under his observation, may have some influence in directing attention to that fruitful source of industry.

The analytical examination of the mineral substances was performed by his associate, Mr. Clemson of this city, who contributed some valuable aid in these investigations.

A copy of this memoir and of the map, and of every essential detail, has been in the hands of a scientific friend, now a resident of this district. He has taken the pains to verify the data upon the spot, which inspires the writer with the greater confidence in making public this communication.

GEOLOGICAL CHARACTER OF THE GIBARA REGION.

On landing at the Port of Gibara, the first rock that we perceive is an ancient coral reef, forming a belt of no great breadth, attaining an elevation of twenty or thirty feet above the sea; and rather more than that above the level of living corals, in the reefs that border the northern coast of this island.

Proceeding south, into the interior, we cross compact white limestones, which are far older than the agglomerated coral limestone we have just quitted.

To these succeed belts and beds of metamorphic rocks, having a magnesian base. Their direction appears to average north-east or east-north-east, but all bear the impress of great change of position, structure and arrangement. As we proceed we perceive rocks allied to diabase, trap, and porphyry, exhibiting additional evidences of disturbance. Then follow a numerous suite of stratified rocks. They consist of varieties of serpentine, ophiolite, metalloide diallage, (euphotide) hypersthene, diorite, schillerspar, feldspar, and amphibole, variously modified and blended. To these may be added ferruginous opal, jasper, jade, chalcedony, quartz, porphyry, calcareous tufa and breccia, diabase or greenstone, and conglomerates composed of fragments of several of these substances. Beds of dark green claystone, and soft dark rocks, modified by heat, alternate with the harder magnesian and hypersthene rocks, and with enormous masses of white metamorphic limestone; the latter of which attains a greater elevation than any other. With the exception of a few partially obliterated corals in the limestone, the rest are wholly devoid of organic remains.

ANTICLINAL AXIS—AND LIMESTONE CHAINS.

In the topographical sketch which was prepared to illustrate this paper, it will be perceived that two principal and two inferior parallel chains of cavernous limestone mountains range along this part of the island, in an east-north-east direction. The first or northern chain comprehends those lofty, isolated, and singularly shaped mountains which are recognised so far at sea: comprehending *El Paramo, La Silla, Cerro Colorado* and *Llavason,* besides some hills of inferior note. One cannot contemplate their remarkable outlines without receiving the impression that the masses of which they are composed, have been thrust up from below. This conclusion is much strengthened on a more particular investigation, when it is discovered that this chain is the centre of a great anticlinal arch. From this axis the whole series of rock formations in the country are tilted in opposite directions. In the area on the north, forming a belt extending to the sea coast, eight or ten miles broad, all the rocks decline at an angle of at least forty-five degrees towards the north. On the south side the axis, and to an equal breadth at least, the strata all dip at an average angle of sixty-five degrees southward, or in the opposite direction to the first.* Of the longitudinal extent of the anticlinal axis we know that it is at least thirty miles, that being the extreme limit of the observations made by the writer.

The general range of the anticlinal axis, of the four limestone chains, of the mineral lodes and of the rock stratification, have a sufficient correspondence in parallelism; being not far from E. N. E. and W. S. W. Now if we apply to a map of Cuba, and protract this course upon it, we perceive that instead of running longitudinally with the island, it traverses it obliquely. The course therefore, of the island being N. 70° W. and that of the axis, &c. being S. 60° W., there is an angle between them of 50°. It is essential to note this, that it might not be supposed that the axis we have thus far traced, followed the prevailing direction of the Island, but rather of a spur from the central mountains. The same course of S. 70° E., if prolonged, follows the central range of the Island of Hayti. If there were no change in the course of the copper lodes, and no deflection in the stratification, within the region under consideration, they would cut out on the south side, not far west of C. de Cruz, which is scarcely probable. It is far more likely that, on reaching the Sienitic region of Holguin, the series is deflected to the west, and may then follow the general direction of the Island. This is proved by following the Gold Lode N. W. of Holguin—which runs N. 55° W.

We were inclined to the belief that the area which lies to the north of the anticlinal axis has undergone a greater metamorphic change than the area to the south. In both instances it appeared that the disturbance and igneous alteration of the rocks were greatest at the parts which are nearest to the anticlinal axis. Another important circumstance

* The details of the admeasurements of this southern dip, at the best ascertained positions, show as follows. At the mines of *Sabana Vieja* 70°.—At those of *Buena Isabela* 63°, 67°—70°—and 73°; at *San Augustin* mine 55°—60°—and 65°.—At *Olivo* mine almost perpendicular. Limestone hills south of *Sabana Vieja,* 50°—55°—60°—75° and 80°.—Limestone ridges on each side of the copper region, generally 60° to 70°.—At *Sao Gibara* 50° to 60°.

We have had fewer opportunities to ascertain the variations in the northern zone; but 45° is the lowest observed angle in that direction.

we could not fail to observe. All the isolated limestone peaks and mountains which range in the direction of the principal chain, are surrounded at their bases by trap, greenstone, or diabase, and by greatly modified rocks.

The next limestone chain, in importance, but the third in succession, is at the distance of five miles south from the first. It embraces the *Cerro alto*, the *Sierra Corolito*, *Cerro de Gibara* and the *Toro loco* groupe. This pursues the same general parallel as the first chain, and ranges with the great trap and greenstone ridge of *Loma larga*, which stretches five or six miles to the eastward from *Cerro de Gibara*. In elevation this second range is probably little inferior to the first. Its mountains exhibit similar precipitous faces and are very rarely visited; certainly not by any scientific persons.

The fourth chain, at the distance of two miles south from the third, comprises the *Loma verde*, the conical *Sierra pilon*, *Las Palmas*, *Melones*, and three inferior limestone hills; occupying about ten miles in length on our map. The vicinity of these mountains is less changed by igneous causes, than those we first described. The intermediate area of two miles, between the third and fourth limestone ranges, comprehends what may be more especially termed the mineral region of the savanas.

Far to the south-east, at the distance of seven miles from *Sabana Vieja*, rises the single lofty, conical *Tivisial* mountain, whose outline, as seen from that position, has a remarkably volcanic character.

THE SAVANA REGION.

It is scarcely necessary to premise that the term savana implies a sterile elevated range; for the most part clear of wood, except some detached Palmettos, Mahogany trees, Corojo Palms, Aloes, and patches of thorny shrubs, loaded with flowers. The surface is every where strewed with detritus from the adjacent rocks; and is overrun by a coarse, wiry grass, rejected by cattle.

Innumerable small streams, whose beds are nearly dry, for a great part of the year, wind amidst the savanas; and descend towards the sea. The humid places are distinguishable afar by the characteristic luxuriance of their vegetation. The streams are fringed with rich woodland; and flats of alluvial soil, the most prolific, perhaps, in the world, stretch along their margins.

We are constrained to advert to these natural features; for they are not wholly unimportant to the miner. In the first place, he perceives that the extraordinary undulations of the surface, and the interlocking of the ravines, offer great facilities to his operations of mining and draining the mineral lodes. In an economical point of view, he sees that although the mines are seated within areas of absolute barrenness, they are in close proximity to others of surprising fertility; capable of sustaining a dense population connected with his operations. Nothing can be more favourable to him than this happy combination of circumstances.

Whilst taking a rapid sketch of the geology of this district, we enumerated the rocks which occur there. With the exception of the igneous rocks, whose position is, of course generally obscure and unconformable, the whole series is stratified, or at least it bears

evidence of having been originally so. They are extremely variable in structure and composition. Whilst some are compact, crystalline, and abound in metalloide diallage and hypersthene, others are fibrous and magnesian, readily decomposing in the atmosphere. With the serpentines occur also the euphotides. One can rarely traverse the savanas, even for the space of a few hundred yards, without meeting with irregular masses of diabase, amidst the ordinary serpentines. At *Sabana Vieja*, for instance, the prevailing rock is serpentine; one variety of which is soft, talcose, and easily worked in the mining operations. Another variety is much harder; of a dark green colour, accompanied with crystals of diallage of various colours, but most commonly of a bronze metallic lustre. This quality is so abundant here that we not unfrequently apply to it the name of Sabana rock. A third species is so compact as to require blasting, when it is encountered in shafts and adits. Amongst these beds occur others of very hard trap rock, or of diabase; also of quartz and hornblende. Some talcose fibrous beds, with veins of asbestos, occasionally intervene, and accompany the pure serpentine. Bands of metamorphic rocks often intrude. In fact, so variable is the geological composition of this district, that scarcely two cubical yards can be found, which precisely assimilate. An attempt to define these varieties, would extend this article to a wearisome length. Such multitudinous and ever changing characters present themselves, on all sides, that it would be a hopeless task to particularize them. In most of the mines where galleries, and shafts have been driven, this varying character was perceptible at every foot, and indeed, at every inch of progress. A museum might be filled with specimens from a single locality.

WHITE LIMESTONE.

It has already been remarked that the rock which attains the greatest elevation in the Gibara region is the compact modified limestone. Although it may be true that this elevation may be due to an upheaving force or thrusting up from below, yet it seems certain that this rock is contemporaneous with the surrounding savana series. This is clearly exemplified at certain points, a few miles remote from the anticlinal axis; at which points it is seen distinctly interstratified with, and consequently of the same age as, the magnesian rocks.*

As we approach the Port of Gibara from the Bahamas, the aspect of the coast is bold and striking. Mountains of strange forms, and isolated bluffs with precipitous faces; and serrated ridges; elevated saddle-shaped masses, steep and bare of vegetation, and shining white in the sun's rays, range along the coast, at the distance of a few miles inland. When we approach nearer, and pass amidst them, to the undulating savanas in their rear, and note them stretching far away to the east and to the west, we perceive

* It can neither be the lithographic, cavernous "Calcaire de Guisnes" described by Humboldt near Matanzas and Trinidad, containing fossils of the age of the London clay; nor is it the "White Limestone," of Mr. D. la Beehe, in Jamaica, whose fossils are also of the same age as the "Calcaire Grossier." This Calcaire de Guisnes is the same rock which apparently forms, to the eastward, the limestone of Hayti; to the south the white limestone of Jamaica; to the south-west the Calcaire de Caribe in the environs of Cumana; and to the west the arid cavernous limestone which occupies the peninsula of Yucatan.

ourselves surrounded by objects highly attractive by their novelty and by their great geological interest. From the midst of the arid savanas, as well as from the lower wooded plains, arise those lofty detached mountains of compact marble, whose unusual shapes, and whose white, vertical escarpments, contrast strongly with the brown, sunburnt hills of serpentine; and confer such a peculiarity on the contour of the coast; and furnish to the far-off mariner such conspicuous landmarks.

On reaching these mountains, their precipitous cliffs appear to be distinctly striated or fluted, vertically; having resemblance to clusters of enormous columns, hundreds of feet in height. At first we attributed this appearance to the possibility of vertical strata. On a nearer examination no trace of stratification appeared. We saw that this columnar appearance was simply derived from the erosion of the escarpment, into deep vertical grooves. On the mountain of *La Silla*, this phenomenon is beautifully exhibited. When, from its summit, we looked down upon the numerous spurs of this saddle-shaped ridge, and upon its surrounding indented masses, we seemed to perceive an assemblage of groups of enormous crystals of white rock, distributed over a space nearly a mile broad and two miles long; shooting upwards from the dark woods below. From the bases of several other mountains equally characteristic views arise; in the resemblance to snow-white basaltic pillars, clear of vegetation on their sides; except here and there an aloe, or some flowering shrub rooted in a crevice. At a short distance the illusion is equally perfect, when we look towards the jagged outline of the crest, it would seem as if an entire mountain, a thousand feet in height, constitutes one vast group of crystals.

The Gibara river is, in many places, crossed by calcareous bands; and, near the great anticlinal axis, before adverted to, the masses are frequently traversed by a beautiful network of delicate *quartz veins*. They also exhibit evidence of having been greatly shattered, broken up, and distorted. Their fragments have been subsequently re-united by siliceous cement; but their original continuity and parallelism of deposite, are nearly obliterated. In other cases, all traces of stratification have been removed from the now perfectly compact mass.

Two miles to the south of the plantation of *Gibara arriba*, our map shows a couple of nearly circular hills, or great mounds, of compact limestone, in the range of La Silla; apparently surrounded by, or thrust up from beneath, an area of diabase. The summits of these somewhat conical hills, are not altogether solid limestone, but consist of an accumulation of shattered masses of that rock, piled rudely upon each other. The weathered surfaces of these calcareous masses, are worn into deep holes, with intermediate points, somewhat dangerous to walk upon. In this respect it exactly resembles the waterworn limestone and old coral rock, which on the Cuba coast, are now daily subjected to the action of the waves. I may add another instance, more recently observed by me, in the case of the Tully limestone of New York, wherever the surface is exposed to the erosive action of the waves of Cayuga Lake. But in the hills of our first limestone chain, in the great anticlinal axis of Gibara, wherever any vertical escarpment prevails, and even where the sides of the detached masses have steep faces, we observed them furrowed in perpendicular grooves: thus presenting that appearance of columnar arrangement, which we before noticed on a more magnificent scale. This rock is sonorous when struck; reminding us of the musical ringing sound commonly produced by chalk flints. The fracture

is sharply conchoidal; the texture is perfectly compact, and inclined to waxey. It burns into a superior quality of lime. In the absence of more appropriate names, we called these two hills, the Wild Dog hills, because they afforded secure retreats to the numerous wild dogs with which the country is infested.

On the southern borders of Sabana Vieja, corresponding with the fourth limestone chain, appear two other conical hills, which seem to rise up from the midst of the surrounding Savana rock. The metamorphic influence is less observable than in those rocks which are near the anticlinal axis. Here the stratification of the white limestone is distinct and undisturbed, except so far as may be indicated by a flexuous or undulating arrangement of its beds. In the westernmost of these two hills the general dip of the stratification is fifty or sixty degrees, to the S. E. For the most part the beds are thin; some of them contain long, flattened, red, cherty nodules; or the mass is interspersed with seams of flesh-coloured calcareous rock, from two to eight inches thick. The easternmost hill also consists of thin wavey beds; which, along the crest of the ridge, dip as much as seventy-five or eighty degrees to the S. E. In this case, the limestone is mottled with reddish nodules, and interstratified with similarly coloured red seams.

The colour of the Gibara limestones exhibits various gradations, from a pure white. These tints are always extremely delicate; and are cream-coloured, slightly greenish, yellowish, or even pink. In structure this marble is, for the most part, beautifully fine and compact:—too much so, it is said by architects, to admit of its adaptation to external building purposes. But for finished, delicate work, in the interior; and for the ornamental departments of architecture and sculpture, it appears to be well adapted.

Upon the flanks of most of these mountains, between the greenstone and our compact limestone, occur tufaceous deposites; derived, doubtless, from the latter, and brought down by numerous descending springs. This soft tufa invests various substances, and contains beautiful impressions of leaves and vegetable fragments. We have observed this, in particular, near the base of *La Silla*, and in the direction of *Llavason;* where extensive marley tufaceous accumulations attest the disintegration of the neighbouring limestone. Often this tufa envelopes fragments of various rocks, and after consolidation, represents a variety of breccia. The streams of this country, particularly near the anticlinal axis, abound in instances of such aggregations. These, however, must not be confounded with the tufa which is derived from the decomposition of the old coral rocks, near the coast: such, for instance, as that which, near Havana, is used, somewhat extensively, in the making of carbonic acid gas, for the manufactory of soda water.

It is a very prevalent character of the Gibara limestone, that it contains or embraces large masses of carbonate of lime, of comparatively recent origin, enveloping shells. We account for this on the principle that they occupy in the solid form, what were formerly open fissures. This new rock is customarily of a reddish colour, generally quite fetid; and encloses organic substances of which we shall speak hereafter. If the enclosing limestone ever contained organic remains, their forms have been obliterated by the changes of which we have such satisfactory evidence. The honeycombed irregularities of the surface, especially in the limestone of the First Chain, exhibit sharp projecting points, and innumerable round holes, an inch in diameter and two or three inches deep, resembling auger holes.

We have sufficiently adverted to the extensive changes of position and inclination, and the striking modifications visible in the composition of almost every rock we have seen on this quarter of the island. Towards the western part of Cuba, this influence, among many other manifestations, is seen in the injection of liquid petroleum and mineral pitch, not only in the form of veins in the old stratified rocks, but in filling cells within the chalcedony and quartz veins by which those rocks are traversed. In the intermediate area under consideration this modifying influence is displayed in the partial vitrifaction of the serpentine and allied rocks;—in the opalized condition of the materials at the outcrops of its mineral veins;—in the admixture and close proximity of undoubted igneous rocks;—in the conversion of quartz into a species of porcelain;—in the kneading together of the horizontal strata and laminæ, into contorted and fantastic forms in some cases;—in the complete obliteration of these original planes of stratification in others;—in the destruction, with a few exceptions, of all traces of organic forms; and in its conversion from a stratified state to that of a compact mass.

THE LIMESTONE MOUNTAIN OF LA SILLA—OR THE SADDLE.

We shall now proceed with a few details of this remarkable mountain, and, in so doing, our description will not be greatly inapplicable to several others in this first or northern chain. We have only approached it from the north and west, where it presents a precipitous escarpment, whose summit, like that of the Cerro Colorado, or Red Mountain, is attainable only at one or two points. The barometer being injured in the ascent, no admeasurements of altitude, to be relied upon, in the emergency, were undertaken. The principal crest was found to be a sharp ridge; a mere wall of pointed rocks, which descended vertically on both sides. Here then was the keystone, as it were, of that great anticlinal arch, which stretches far away in a W. S. W. direction and its reverse. From its upheaved centre declined the vast series, the innumerable varieties of rocks, at a high angle, northward towards the sea and southward towards the mineral savanas of the interior, which we shall hereafter describe.

THE CAVES OF LA SILLA.

The Gibara rock, apparently the same as has acquired in Western Cuba, and in Jamaica, the name of cavernous limestone, presents, within the mountain of La Silla, some examples of these caverns well worthy of our notice. At the foot of a perpendicular cliff is the entrance to the caves of La Silla. They branch to the right and to the left, so as to form suites of chambers, one beyond the other. The suite which lies on the west or left hand side of the main entrance or vestibule, is three hundred and fifty feet long. Into the eastern range we did not penetrate, on account of the contraction of the entrance, even within a very few years, by the accumulation of recent carbonate of lime upon the walls; or by what is not unaptly termed "growing up." The interior of the first bears a rude resemblance to an ancient Saxon Crypt, with its heavily groined roof and its massy pillars and buttresses, composed of continually augmenting stalactitical matter. This con-

stant tendency to encrust the walls, proportionally contracts the areas of the chambers. Already the entrances to several of them are thus for ever closed. Upon the floors of these caverns are strewed and accumulated to a thickness we had no means of estimating, myriads of dead snail and other shells, intermixed with the dung of thousands of bats. We felt assured that in this brick red mould, to which the bats have, for ages, contributed:—in the countless multitude of dead and decomposing land shells, for which this cave seems the tomb or charnel house; and in the slow, yet certain, conversion of the whole mass into a new and solid crystalline rock, we saw the immediate origin of those beds of shelly and sparry limestone, at first sight so perfectly inexplicable, which we now proceed to describe.

LAND SHELL LIMESTONE.

At numerous points during the ascent to the mountain of La Silla, we observed coarsely crystallized carbonate of lime, of a red tinge, crowded with fossil univalve shells, which at the first glance seemed to resemble the tertiary. We were the more readily led to adopt this hasty opinion, because the observations of Humboldt and De la Beche, in other positions within the tropics, had led us to look out for calcareous formations of no very ancient date. We did not immediately discover the true nature and origin of this fossiliferous lime rock of La Silla. Subsequently we perceived that it there occupied what had once been open spaces, fissures, and even caverns, within the compact ancient limestone of this mountain. Occasionally, it was only a few inches thick. At one point it was from ten to thirty feet in thickness, and fifty feet in breadth; externally visible. The latter occurred—and this is important to notice,—at the height of only fifteen feet below the highest summit of the precipitous ridge. It here consisted of numerous layers, most of which emitted an offensive animal odour, when fractured.

After two or three other visits to La Silla, we traced with facility the extent of several of these shelly deposites. We acquired an insight into their origin: and we became familiar with the process by which they were consolidated. We perceived that these fossilized univalves were, in fact merely contemporaneous with living genera and species:—that they were referrible to *land* shells, such as now every where abound in the mountain. and that crawled beneath our feet; to the number of at least nine or ten species. Their inhabitants, at certain seasons perhaps, are wont to retire into the dark caves and the extensive mountain fissures; and some, probably, wholly existed in those sequestered situations. There the dead and unoccupied shells lie in countless numbers; mixed with that red soil of which we have spoken, as derived from the dung of bats. By the stalagmitical process, going on in the caves, in their walls and floors, the shells and other substances, fortuitously within its influence, become enveloped in compact and crystalline carbonate of lime, resembling a far more ancient rock. The operations of infiltration and consolidation, and the enclosing of multitudes of shells, is seen uniformly proceeding, until fissures, and caverns, and irregularities, are alike filled up, and until, finally, the newer limestone, overflows the surface of the older.

We were, at times, when examining this, very recent, formation, reminded of the fetid

osseous breccia of Gibraltar. We even here met with fragments of bones; and it did not appear difficult or improper to refer those animal remains, enclosed in this modern limestone, to the *Hutia*, or large native Indian rat, which attains nearly to the size of the American raccoon. This animal still abounds in the woods, and amidst these mountains of Cuba; and we actually saw them, in abundance, living on the very site where we recognised their partially fossilized remains; and inhabiting the rocks wherein their bones are thus beautifully preserved, and perpetually entombed.

It appears almost incredible that the testacea should accumulate in such vast numbers; sufficient, indeed, to form, with the aid of other accompaniments, distinct stratified masses within the mountain. We know that other organic remains, besides those which we have mentioned as the most conspicuous, have contributed to swell and to vary the amount. We well know that these same caverns are occasionally, if not constantly, tenanted by other inhabitants, than such as we have named:—by iguans and lizards; by frogs of numerous specimens; occasionally by land crabs;—by the large *Majas*, the chicken snake of Cuba, ten feet long; by the wild hog and dog of the country; without mentioning the innumerable numbers of the insect tribes; the scorpions, the tarantulas, and a host of others. We must not forget how singularly adapted, beyond any other perhaps on the globe, are the climate and soil, and vegetation, and other favouring circumstances, of this island, to the production, the maintenance, and the multiplication of animal and insect life; especially in solitudes like those of the mountains of *La Silla* and *El Paramo*. Is it, therefore, remarkable, that in turn the relics of all these animals should be enveloped in stalagmitical matter, and should form a rock which is characterized by such a singular assemblage of organic exuvia? But having witnessed in the caves of La Silla the myriads there congregated, we were at no loss to perceive that these dead shells, and occasionally other matters, intermixed with the red soil, and undergoing the unceasing process of consolidation, by infiltration of carbonate of lime, would at no very distant period, assume the substance of a solid fossiliferous marble, such as in fact we saw abundantly elsewhere.

There yet remains an additional fact to be adverted to; and it is an extremely interesting one. Amongst the land shells, were observed, occasionally, some univalves that were unquestionably *marine*. This fact had, originally, greatly contributed to our perplexity. It was an enigma not to be solved at a glance.

But the mystery *was* cleared up, when we discovered that the active and real transporting agents, in this case, were the *soldier crabs*, which frequent the solitary places, and which use the littoral shells for their temporary residences. Numerous individuals of the genus *Pagurus*, at certain seasons, resort to the sea-shore; and they are often seen, in great numbers on their travels. They return from their pilgrimage, each dragging the deserted shell of some marine univalve; for many a weary mile, over the sands and the wilderness; over swamps, and the most rugged rocks. Thus, like the pilgrims of the olden time, each bearing his shell, to denote the character, and to indicate the extent, of his wanderings, they proceed mile after mile, into the interior; traversing dense woods and climbing the highest and steepest mountains. At the distance of eight or ten miles from the nearest sea beach, we trace them up to the very crests of the most precipitous escarpments of La Silla: hundreds of feet above the ocean. Finally, when the habitation,

to seek which—impelled by a mysterious instinct,—the animal has wandered and toiled so far, and has encountered so many perils,—becomes too circumscribed for its accommodation, he is constrained to desert it for some more suitable shell; leaving the discarded one, amidst the land shells and the animal exuviæ of the caverns, there to form a new rock, and a geological puzzle, and to furnish materials for the elaborate speculations of some future savan.

MARINE UNIVALVES SEEN ON LA SILLA.

R. C. Taylor.

Trochus ———
T ———
T ———
Turbo muricatus.
T ———
T ———
Littorina ———
Monadonta.
Probably some other species, unobserved.

LAND SHELLS OF LA SILLA.

Examined by Isaac Lea, Esq.

Cyclostoma sulcata, ...	Lamarck.
Pupa Murnia, ...	Lam.
Caracolla marginata, ...	Lam.
Caracolla ———	(?)
Helix microstoma, ...	Lam.
Helicogena auricoma.	
Helix muscarium, ...	Lea.
Helix purpuragula, ...	Lea.
Clausitilia, ...	(?)

ADMIXTURE OF FLUVIATILE, MARINE AND LAND SHELLS.

The shores of the bays of the northern coast of Cuba furnish interesting examples of the commingling of shells, the occupants of which had respectively lived under very different circumstances. Several streams, for instance, empty into the Bay of Gibara, and bring down, during floods, vast numbers of land shells from the high lands. With these are numerous small fresh water univalves, the *Neritinia virginea* of Lamarck. No bivalves were observed in these rivers. Were any geological change to take place, by which these accumulated exuviæ of the sea, the rivers, and the land, would be consolidated, as the organic matters are at this moment subjected to in the mountain caves, and at some remote period be investigated by a naturalist, he would see here but a repetition of the phenomena of supposed estuary deposites, which have more than one parallel in remote parts of the globe.

CORAL ROCKS AND REEFS OF DIFFERENT AGES.

In the calcareous rocks of Cuba we have seen nothing to countenance an hypothesis of a gradual passage, from the submerged reefs of living corals that encircle the island, to the older fragmentary coral rock that fringes the coast, at some twenty or thirty feet above the sea: and still less to the metamorphic limestone of the interior. We are able, in more than one position on the coast, to see, very distinctly, this compact limestone dipping below the old coral rock, at an angle of forty-five degrees, northward. Beyond the latter extends the reef of living corals; ranging in advance of the coast line, so as to leave an intermediate space of shoal water, called the *Baxo*, a quarter of a mile or so in breadth, and abounding with fish.* At all times, but particularly when there is a swell to windward, the surf breaks with violence upon this reef, so as to be heard many miles inland. At low water some of the corals are level with the surface, and others are suffi-

* Loudon's Magazine of Natural History, Vol. IX., p. 449.

ciently below it to admit of the passage of a boat, when steered with caution. Their arrangement is not unworthy of notice, being so disposed as to offer much less resistance to the landward motion of the swell, than would be anticipated. They present, not a solid surface, a vertical obstacle, as has been often stated, but a partial obstruction to the water which rushes through or between numerous coral groups. This is owing to their being arranged somewhat in rows or tiers; not parallel with the reef, but disposed at right angles to it: and admitting the broken waves to pass amidst them, into shoal water. Thus, for years, perhaps for ages, the thundering surf may fall harmlessly upon and amongst these beautiful productions of nature. The effect of the barrier, according to this arrangement, is far more effective and permanent, as a breakwater, than if it had presented the solid, abrupt wall which a reef is commonly represented to be.

Bordering the beach or shore, next the Baxo, is the older reef, furnishing ample evidence of a change of level. This, for awhile, appears as a low perpendicular cliff. It then passes obliquely inland, to westward. Between it and the present beach is now a ridge of low sand-hills, which are thickly covered with bushes, such as the wild fig, the cocoa plum, the sea grape, and a few aloes, palmettos and creeping shrubs. Like the older limestones, this rock is deeply honeycombed, and contains large detached meandrina, madrepores, porites, caryophillia, millepora, astreæ and others; intermingled abundantly with spines of echinites and well preserved, but colourless, shells. In this old coral rock we notice extensive fissures, running sometimes many hundred feet, parallel with the coast line. These fractures may have resulted from the same cause which heaved up the old reef to its present elevation; and then again the latter may have been due to, or influenced by, the movement which, at a distant day, threw the entire mass of substrata into its inclined position, as we now see them. Coral likewise occurs at a much greater elevation on the plains of the interior. Similar phenomena occur on the shores of the island of Jamaica.*

Before we quit the subject of coral reefs, in these latitudes, we may make mention of that remarkable chain of keys, which stretches seemingly in a line, parallel with the north coast of Cuba. These *Cayos*, whose numbers seem interminable, are for the most part, covered with a dark vegetation. Some of them are a mile or two long; others are much smaller, and the trees, by which they are covered, seem to rise out of the sea. Groups, and clumps, and groves of trees, appear as if growing in the water. Occasionally a single tree appears the solitary occupier of its own little island.† From the *Cruz del padre* to the *Punta Icacos*, and still further west, is an almost uninterrupted chain of wooded keys. It occurs at the distance of a few miles from the main land, to which it seems an important protection; at the same time affords the finest fishing grounds, of which the aboriginal Indians well knew the value.

THE MINERAL REGION OF GIBARA.—COPPER.

Discovery of Copper Lodes.—Previous to the year 1830 the existence of copper lodes on the north-east side of Cuba was unknown. They were first discovered in the savanas,

* De la Beche, Transactions of the Geological Society of London, Vol. II., part 12.
† On the old Spanish maps this group is named the *Jardin del Rey*.

during an ineffectual search for gold: and the denouncement of *San Fernando* was then commenced to be worked as a copper mine. Several others were soon after discovered; and legal possession of them was secured, according to the usual Spanish forms, to the proprietors, by authority of the local government. Among the earliest of these was the mine of *San Augustin*, followed by the *Buena Isabela*, in 1835. Stimulated by the success which attended the working of the Cobre mines, to the south, the mineral researches were here prosecuted with activity, and not a savana in our district escaped a strict exploration. The principal copper lode at *Sabana Vieja* was discovered in 1835. Careful examination was made of this denouncement in the following year, and the outcrops of eight copper lodes were traced, within the breadth of a few yards. Of all these we shall shortly speak; but, necessarily, with brevity.

Character of the Copper Lodes.—It has been stated that the mineral veins of this district occur in stratified rocks, the most prevalent of which is serpentine. We have shown that these lodes were contemporaneous with those formations: that is to say, they do not traverse any rocks, but are interstratified with them. Wheresoever our examinations extended, we found that these lodes have regular walls, containing much silicate and carbonate of magnesia; and having polished sides or surfaces. Further, we demonstrated that these copper lodes maintain nearly uniform directions, parallelism, and inclinations, that is to say, the prevailing course is about E. N. E., and the average dip to the south is about sixty-five degrees. As is usual with cupriferous veins, the surface ores, comprising under that head those within fifty or eighty feet below the outcrop, materially differ from the mineral matter at a greater depth. The most prominent varieties of these are the silicates, the carbonates, the oxides, and the sulphurets. Native copper is not unfrequent; but not lower than thirty yards from the outcrop. In the mine of *San Fernando* it occurs in masses of from ten to two hundred or more pounds' weight.

San Fernando.—This mine has heretofore been worked upon the old Mexican system, if system that can be called, which consists of an intricate labyrinth of shafts, slopes, drifts, and holes; winding in most inexplicable confusion, without reference to ventilation or drainage. Subsequently, under better advice, the lode has been intersected by an adit. The ore is a sulphuret, of a dark bronze green, inclining to a bluish gray colour, rich in copper, and intermixed with excellent gray and vitreous copper.*

Socorro, discovered in 1831, and *San Antonio:* the latter has a good lode of rich ore.† *San Juan*, and *Mina Innocentes:* all these have Spanish owners, and have made very little progress.

Olivo.—A Boston undertaking. Its adit was commenced in 1836; a good lode struck in 1837, at two hundred and forty feet below the summit of the savana. The magnesian ground in which this lode occurs is soft and favourable for mining.

San Augustin.—An American undertaking. The mine is eleven miles from the *Embarcadero* or landing place of the Gibara river. Course of the lode E. N. E.—dip 60° to

* Yielding 33.60 per cent. T. G. Clemson. Weaker surface ore below an average 13.56.

† Varying from twenty-three to twenty-seven per cent. of copper.

65° to S., of very promising character; the outcrop ore being the richest in the district.* Three feet thick in the shaft, at forty-six feet depth.

Prosperidad,—Santa Isabel,—San Nicholas.—Separate lodes included in the last denouncement.

Perseverancia.—An American denouncement. A shaft on the lode gave good ore at fifty feet depth.† A second lode is included in this area.

Buena Isabela.—Twelve miles from the Embarcadero. Course E. N. E., along a ridge. A thousand feet of work done in shafts and levels. Three feet thick of solid ore, at ninety feet depth, raised in masses of fifty and one hundred pounds weight; and one mass of three hundred and eight pounds, part of a block of more than a thousand weight.‡ Two smaller lodes occur near. A Philadelphia concern.

Loma de los tibis.—Opposite to *Cerro alto.* But little work done here.

Sabana Vieja.—An American and English undertaking. Possession given by the governor in 1836. It is twelve miles from the Embarcadero, which is one and a half mile from Gibara Bay, and four and a half to the point or town. Eight copper lodes have been defined within this denouncement; and four others are but partially traced. Course of the lodes, with slight variations, N. 56° E., dipping 60° to 70° to S. In some places the outcrop of lode No. 1, is twenty feet and at another point is thirty feet wide.§ No. 2, is six feet between the walls, good bronze-coloured sulphuret. No. 5, lode four or five feet between the walls—rich carbonate, silicate and red oxide or tile ore, in masses attaining to seven hundred pounds weight.

Traces of other copper lodes occur at *Loma larga, Higal, Loma larga de la Palma, Llavason, Sao Rabon, Saoito de los Ranchos,* and several other places.

Chrome Ore—Occurs in prolonged masses, rather than in veins, in several places in the serpentine region; generally in connexion with copper lodes. A large quantity of this ore has recently been mined and shipped to Baltimore; and some has been manufactured on trial in Philadelphia. These metalliferous beds occur on both sides of the third limestone chain.

Iron Ore.—At *Rabon* a very large vein of compact black iron ore.

Magnetic Iron Sand.—Abundant at *Loma larga.*

GOLD.

Auriferous sands and beds.—The quartzose rocks, the quartz veins, the alluvium, and the river sands, around the City of *Holguin,* have long been known to contain gold,

* Four assays, T. G. C.—34.00—23.30—51.60—34.70—16.40—per ct. of copper. One assay J. G. T.—27.54 per ct.
† Ore at bottom of the shaft 26.40—per cent.—T. G. C. Copper.
‡ Six assays, T. G. C.—15.50—14.80—7.10—22.40—27.20—9.40—and six per cent. (S.)
§ Seven assays of lode No. 1.—T. G. C.—8.20—10.30—11.50—20.00—25.40—37.64—32.00 per cent.
Four assays of lode No. 2.—36.50—39.50—16.40—9.20—per cent. copper.
Eight other assays of No. 2.—T. G. C.—14.20—5.70—15.40—17.50—13.00—14.90—23.30 and 13.50 per cent.
Five assays of lode No. 5.—T. G. C.—22.80—34.00—25.40—18.20—20.00 per cent.
Lode No. 7.—T. G. C.—13.20 per cent. Another lode—19.40 per cent.

which has been collected by the simple process of pan washing, but no important works have been ever undertaken, on an efficient scale, for obtaining the precious metal. Certain quartz veins here, contain an amount of gold which would be thought very rich, and eagerly worked in Europe: but the attempt to work these expensive rock veins has, for the present been abandoned. The late investigations into this matter have fully pointed out the sources whence the auriferous sands are derived. It is in the soft fragmentary beds, where the gangue consists of a deposite of miscellaneous rocky and ochreous matter, in a comminuted form, that the more recent researches have been applied.

San Juan Bautista Gold Mine—Is situated in the *Partido* of *Guago, Balis,* five miles north-west of Holguin. At the surface this seam, or vein, for it appears to have regular walls, is four feet and a half wide; improving as it descends, and the ore resembles the *Jacotinga* of *Gongo Soco,* in Brazil. Like the mineral country nearer Gibara, its surface is undulating; diversified with patches of savanas and tracts of rich wood land; the mine being situated within the latter. The neighbourhood is intersected by numerous rivulets, capable of supplying the water for dressing the auriferous ores. We have received recent details of this undertaking, both from the proprietor and from one who devoted several days to its investigation.

The auriferous vein bears north 55° west, dipping to north-east, at about an angle of 45°. It is composed of a friable, brown and red ochreous earth; intermixed with small quartzose fragments: between walls of magnesian rock, and decomposing schistose rock; in fact corresponding with the savana rocks noticed elsewhere. Very little gold can be detected by the unassisted eye. By an imperfect process more than four ounces of gold were obtained from a ton of this ore, worth therefore about seventy dollars per ton of ore. Large as this result certainly is, it is fully confirmed by assays made subsequently in Philadelphia, and by another made in London.

Professor Booth found that the metallic matter resulting from the experiment consisted of at least two-thirds or three-fourths of gold, united with a white metal, probably iridium or osmium, which was insoluble in nitro-muriatic acid.

Portions of ore analyzed in Cuba produced three to five ounces of gold per ton of ore. Three other assays in Philadelphia showed the presence of more than five ounces per ton. At present all operations are suspended, at the mine.

CONCLUSION.

It is time to bring this article to a close. The geological character of this region, and the value of its ores, have been detailed as minutely as our limits permit. The field is indeed a promising one; and there is small risk in predicting, that the mineral ores, of which we have made but brief mention, will, from the moment of putting the mines into operation, add immensely to the already abundant resources of this remarkable island. We think it will then appear that industry and skill will be as amply remunerated at Gibara as at Cobre; and judging from the past, it seems very probable that these undertakings are now only awaiting the resources, the capital and the enterprise of Englishmen and Americans, rather than of native adventurers.

ARTICLE VIII.

Notice of Fossil Arborescent Ferns, of the Family of Sigillaria, and other Coal Plants, exhibited in the Roof and Floor of a Coal Seam, in Dauphin County, Pennsylvania, by Richard C. Taylor, F. G. S. &c. Read May 30th, 1843.

I AM desirous of placing on record a description of certain remarkably developed specimens of vegetable fossils, of great magnitude, which have come under my observation, in the most southern of our Pennsylvania Coal Fields. It is not often that presentations, on such a scale, can be studied so advantageously as in the present instance. I willingly admit, that they merit description from a much more accomplished naturalist than myself.

Those now about to be described are, or were, displayed during the progress of working a Gallery or Drift, several hundred feet in length,* in a Coal bed to which the name of "Perseverance Vein" has been given. Its position is towards the western extremity of the Schuylkill Coal Field, thirteen miles east from the Susquehanna River.

I should have felt less disposition to enter upon this task, had detailed descriptions of interesting exposures of coal vegetation, on an enlarged scale,—acquired during the progress of practical operations, in our mines,—been more frequently furnished to science. For illustrations of this instructive character, we in vain search among authorities which are recognised as of the very highest scientific reputation. Their specimens, selected for illustration, generally represent but a minute section, a mere fragment of these gigantic plants, and are limited to the exhibition of the characters of their bark or of their leaves. But these samples transmit to us no conceptions of the actual scale, the true magnitude, to which this magnificent flora attains; any more than a single brick conveys an adequate idea of the architecture of a building.

M. A. Brougniart, himself the author of a standard treatise on fossil vegetables, became fully aware of the necessity for calling the geologists to his aid; ere he could perfect the splendid work which he has communicated to the scientific world.† "No one knows better than myself," he exclaims, "the difficulties inherent to such a subject, and the imperfections, impossible to avoid, which may be found in the work which I publish. This work will present only the first rough sketch of the vegetation of the ancient world;

* Length of excavation, five hundred and fifty-eight feet.

† Histoire des Végétaux Fossiles par M. Adolphe Brougniart.

and it will be still many years before we can trace a more perfect picture. To achieve such a result, it is necessary that the geologists and the botanists should unite their efforts; in order that none of the objects, requisite to enlighten a subject so difficult, should be neglected."

It rarely happens that the persons who are practically employed in coal mines regard the fossil flora by which they are surrounded, as in a museum, with sufficient interest to take adequate note of the natural objects which, from time to time, present themselves. In fact they are, from obvious circumstances, unfitted for observation; or rather, for noting, with that degree of precision that commends itself to our confidence.

Upon the geologists, but more especially upon those among them who direct the explorations of our mines, the charge mainly devolves of observing and recording the phenomena of fossil vegetation, as they are brought to view from the depths and darkness of the earth. Upon these instructed observers, rests the interesting duty of communicating intelligence respecting those long buried productions of nature, which they have assisted in developing, on a magnificent scale, within the galleries and the recesses of the mine.

However elaborately these specimens may, at first, be displayed upon the walls of our coal veins, those who are practically engaged there, well know how soon those relics are defaced or despoiled of their freshness and beauty, by the operations which are there incessantly carried on by the miner and his assistants. Sensible of this, and with a view to the preservation, upon paper at least, of the magnificent memorials which I am about to describe, I have made it a special object, during upwards of a year, to trace out on the most extended scale that the works permitted; to make admeasurements; to preserve specimens; and to take drawings, from day to day, as the excavations proceeded and the fossils were laid bare, of whatever details might afford instruction relative to the character of this ancient flora. The result of this labour is now before the present meeting.

The coal of the bed in question is in the transition state, often denominated semi-bituminous: that is to say, it contains upwards of sixteen per cent. of volatile matter.* Its position is highly inclined; dipping not less than seventy degrees to the north. Several other smaller coal seams occur in this locality, (the Third or Sharp Mountain,) alternating with a countless series of conglomerates, grits, sandstones, argillaceous shales, and fire clay: all inclining northward, at from seventy to seventy-nine degrees. Nearly every one of the numerous coal seams we have explored in this quarter,—often very small and consequently unprofitable for working,—has a floor of soft slate or fire clay, and a roof of coarse siliceous conglomerate. This fact is distinctly exhibited in the two sections, and in the ground plan, which accompany this memorial.† The conglomerate or pudding-stone, spoken of, is compact and dense: it is extremely difficult to blast, and

* Proportions of Carbon,	76 10
Volatile matter,	16 90
Ashes,	7 00
	100 00
Specific Gravity,	1 391

† It has only been found practicable, consistent with the arrangements of the Society on the present occasion, to admit of one engraved illustration, of a part of the diagram exhibited by the author to the meeting.

consequently is very expensive to operate in; as all know, to their cost, who have had to pass through it, by drifts or shafts.

The direction or level course of this vein, in the gangway, is from 19° to 25° to the northward of east; that is to say, commencing in a course north 64½ east, it sweeps round to north 71° east. It will be sufficient for our purpose, when speaking of bearings, to limit our description simply to the cardinal points.

Between the north and south walls the interval is eight or nine feet: of which space five and a half feet consist of coal, divided in the midst by a seam, two or three feet thick, of fire clay. Along the course, therefore, of this coal seam, and bounded by its walls, the exploratory gallery has been pursued. With so high an inclination as seventy degrees, these walls are not unsuitably disposed for the purposes of the mine; and are especially adapted to the display of the vegetable fossils, which appear like pictures suspended from a wall, on either hand.

I have said thus much in explanation of local details, because, without them, our position could not be understood.

It has been stated that all the principal coal seams, known to me in this vicinity, have floors of argillaceous matter, called the "bottom slate," and roofs of conglomerate rock In the present instance these lower slates, comprising two thin seams of coal and some thin beds of argillaceous sandstone, are seventeen feet thick, before reaching the next conglomerate, on that side. Turning to the north, the bare wall of conglomerate forms the hanging side of the coal seam, without any separating matter between it and the coal, except from two to four inches of shale, called by the miners the "top slate." This is commonly stripped down in the process of excavating the coal; as the slate here parts more readily from the rock, than the coal separates from the slate: moreover the solid rock forms a safer wall than does the loose shale. Occasionally, as in other veins we have traced, the conglomerate even comes in contact with the coal itself; exhibiting the form of the coal vegetation upon its under surface; and, notwithstanding the coarseness of the materials of this rock, may be often seen moulded into the configuration of the larger plants, which even retain their carbonized bark.

The irregular space between the actual serviceable coal and its overlying puddingstone, is almost entirely occupied with casts of trunks of trees, lying horizontally; that is to say, parallel with the coal.

These preliminary explanations will, I think, render the position of an observer in this gallery, sufficiently intelligible. As he advances forward, towards the east, he has the clay floor of the coal seam, on his right hand, sloping at a high angle towards the north; while on his left, facing the north, the conglomerate roof, or hanging wall, approaches within twenty degrees of the perpendicular. As in every case within my knowledge, the upper surface of the coal and the inferior surface of the overlying rock, are somewhat rough and irregular, forming a remarkable contrast to the lower surface of the same coal, and to the smooth and almost polished face of the subjacent slate. When the circumstances which attended the slow and tranquil accumulation of the one, and the turbulent and disturbed condition of all things at the commencement of the other, are taken into consideration, we shall obtain a ready explanation of the irregular surfaces of all coal seams which have conglomerate roofs.

THE SOUTH OR BOTTOM WALL.

After removal of the coal, the slate floor presents a perfectly beautiful picture of plants and compressed trunks of large trees; mostly in a well preserved state. Until the face of this southern wall has become obscure by the coal, mud, and dirt which rapidly accumulates in these thoroughfares, under the operations of the miners, this exhibition is singularly interesting; and furnishes abundant opportunities for the study of fossil botany.

The coal vegetation, thus favourably presented, belongs, in a great measure, to the class Sigillaria, which plants are allied to the family of arborescent ferns. Of these Sigillaria, or tree ferns, we think we can, with some degree of probability, distinguish five or six distinct species. One other species, also, apparently a Sigillaria, is particularly abundant. Its bark, now carbonized, is at least one third of an inch in thickness. This being removed, the inner surface resembles somewhat the *Syringodendron organum* of Sternberg, (Tab. xiii.) although this is not an uncommon character among the thick-barked varieties. Its longitudinal grooves or striæ are rather irregular, but average half an inch in breadth. The outer bark is roughly marked with an obscure and coarse tissue, and exhibits no distinct cicatrices.

Of the family of Syringodendron, which also has been classed with the Sigillaires, we have apparently one species: of the Lepidodendron of Sternberg, two species; of Stigmaria, one species. From the shales of the outcrop of the vein, we derive two or three species of Neuropteris; three of Pecopteris; two of Sphenopteris, and one of Calamites.

This list is evidently incomplete; and it forms no part of my present undertaking to prepare more than a sketch of the subordinate class of fossil plants.

Among all these, as we have already intimated, the family of Sigillaria is the most conspicuous, and occupies by far the largest space. These gigantic plants are all placed horizontally; that is to say, parallel to the stratification. They seem to have sustained no injury, except such as might accrue from being flattened under great pressure; while the soft clay or argillaceous matter in which they were immersed, has evidently tended to their preservation. These stems are of very large size, as is shown by the accompanying drawing. They cross each other in every direction, and form no inconsiderable part of the mass of clay or mud, on and in which they repose. Among the most remarkable and beautiful of these fossils, is a bifurcated species, whose stems and branches are uniformly bent, or curved. We think we recognise in this species the *Sigillaria elegans* of M. Brongniart. These are somewhat abundant here, and we have met with still more splendid specimens of the same species,* in the imperfect coal and coal shales below the upper red shale. On account of the obscurity of the cicatrices in those before us, baffling specific discrimination, it may possibly be *Sigillaria Knorrii*, (Tab. 156,) which so nearly resembles it; but the probabilities seem to favour the *Sigillaria elegans;* the scaly markings of which are smaller and more closely approaching to our specimens. A further reason for this preference is, that the *elegans* is dichotomous, and we have no evidence that the *Knorrii* is.

* I speak here from memory, as these fine specimens were subsequently destroyed by fire.

The oblique position in which, for the most part, these enormous stems of Sigillaria are disposed, in the floor or south wall of the coal seam, is unfavourable for determining their longitudinal extent: nor shall we ever ascertain it, until a much larger area is uncovered. During the length of several hundred feet in this gallery, not a single case is presented, either of the commencement or the termination of a stem of Sigillaria. With the exception of the one flexuous dichotomous species, mentioned above, the whole are singularly straight, and present no apparent diminution of their breadth, towards their superior extremities. Five or six of these Sigillaires have thirty feet of their length laid bare; and one other has forty or fifty feet long, exposed; without any perceptible change in width during that space. We regret the necessity of leaving so much undetermined. The actual lengths of these noble trunks can only be ascertained whenever, in the future operations of the mine, the coal shall be more extensively removed.

More than one hundred of these straight Sigillaria are shown in our drawing. These are only the best defined among them; selected for illustration. At least double that number exist in that space; but there would have been no advantage gained by introducing them into our sketch. As to their thickness, it may be stated that few stems are so small as two feet wide: many are three feet diameter: four or five of them are four feet; one or two others are four and a half feet; and two are five feet broad, each: differing little, probably, from the original thickness of the living trunks. All these may be verified by consulting our diagram; which was drawn to a scale, from the actual admeasurements of the stems, at the time of discovery.

The exterior or epidermal, and the cortical covering, are in these specimens converted into coal. This carbonizing process, during the imperfect crystallization of the coal, tends greatly to ambiguity; for by this circumstance we are deprived of the only certain mode to which we can resort for determining species. The obscurity, occasioned by this modification of surface, has added to our embarrassments in examining these fossils, and has occasioned no slight hesitation in establishing their specific identity. Where the thickness of bark is considerable, as in *Sigillaria pachydermata* of Brongniart, and the *Lepidodendron rimosum* of Sternberg, the characteristic marking of the cicatrices, when converted to coal, is nearly obliterated. In the case of the species before alluded to, *Sigillaria elegans*, the carbonized bark appears to be only one twenty-fifth part of an inch thick; and, when removed, shows that the inferior surface still bears a modified resemblance to the outer covering.

It seems highly probable that a large proportion of the bulk of the coal itself was derived from the stems and leaves of Sigillaria; for by the appearances which yet remain, they must have stood as thickly crowded, as any of our most densely wooded forests. M. Brongniart has stated that the great number of leaves which the Sigillaires bore, extending along their entire length, and which had evidently been disarticulated and had fallen before the stem was buried in the strata, announce a life of no ordinary duration, and a growth which has required a considerable lapse of time. Notwithstanding this, we observe that the inferior extremity of the trunk presents flutings and cicatrices, which agree, as to size, with those near the top of the same stems, and which are nearly as strongly marked. The trunk has undergone, then, no considerable change or increase in its diameter; nor any remarkable alteration in the state of its surface, towards

the base. These views confirm the remark which has been here already made, respecting the singular maintenance in size, of the diameter of the Sigillaires of our own coal fields.

Respecting the class of plants to which these enormous trunks appertained, we have good authority for placing them among the numerous families of the group of ferns. It is impossible, M. Brongniart contends, to admit that these stems had belonged to vegetables of the class of dicotyledons. No wood of dicotyledonous or monocotyledonous plants, properly speaking, have been found in the coal fields; nor is there any dicotyledonous plant, actually existing, which shows stems regularly grooved, and bearing the organs, which, after their fall, leave cicatrices at all analogous to those of the Sigillaires. The ancient surface, therefore, during the growth of our Pennsylvania coal strata, was overshadowed by groves of gigantic ferns, rivalling in magnitude the trees of our present forests.*

THE NORTH WALL, OR ROOF.

We turn now to the examination of the north wall, or rock roof, of our coal seam. Here an entirely different aspect presents itself; well worth the recital. Instead of an interlaced mass, composed of innumerable thinly compressed and flattened stems, displayed upon a comparatively smooth surface of black clay shale, we have a series of long bifurcating columns whose dark forms are relieved against the lighter coloured conglomerate. We are struck with the fact, that unlike those on the opposite wall, excepting in one species, none of these stems are straight: they all possess remarkable curvatures. Their bark, originally very thin, and since converted into coaly laminæ, readily falls away under the operations of the miner. Much was probably destroyed at a vastly older period amidst the turbulence which attended their prostration. Of this we have some evidence in the occasional marks of rubbing which some of these stems appear to have received. Both circumstances contribute to the difficulty of identifying the species.

All these trees appear to belong not only to one genus, but to a single species. Less numerous—inasmuch as they indicate such only as lived at that remarkable epoch, when the diluvial waters, heaving along enormous masses of sand, and gravel and pebbles, swept over the surface,—less numerous, I say, than that earlier vegetation, which slowly and quietly accumulated at the base of the coal, in the position we have just been considering them,—these prostrated overlying trunks, present even a more interesting spectacle. Seldom has it occurred to witness an exhibition of antediluvian vegetation, like this, of which we have given but an imperfect sketch.

Facilitated by the gradual advance of the work, under his immediate direction, the writer had abundant leisure for observing these remains; and opportunities were not lost to prepare a faithful picture of the most interesting. Ample as apparently were the

* The clay floor of the coal, bearing these magnificent traces of tropical vegetation, exhibits, when broken, in its interior, the grass-like leaves of Lycopodiolite, and Stigmaria. One of the family of Sigillaria, also, (*S. Lepidendrifolia,*) bears leaves which are not greatly dissimilar to those of the former. Leaves of the other and smaller ferns, are not very frequent here. Stigmaria is less abundant than usual in other seams, and has contributed but little towards the composition of the mass of coal.

means of observation, afforded by the excavations, yet such is the magnitude of each individual specimen, that we have again to regret the want of additional space to enable the examination to be followed up satisfactorily. Fortunately, in one or two instances we are enabled to approximate to the probable length of the stems, although in neither case are we sure of the exact character of their terminations. Believing that the absence of more complete data is an insufficient reason for withholding so much as we really do know, I have not scrupled to prepare this memoir.

One of the instances adverted to, a dichotomous specimen, has a remarkable flexuous stem. It would be hazarding too much to guess at its probable length; for both extremities are concealed. Not less than sixty-five feet, however, in extent, is clearly visible. For aught that can be inferred from its present appearance, this tree may have extended thirty or forty feet still longer. The other specimen, the most interesting, in fact, of the group, shows its lower extremity, near what might have been the root. For the first forty feet there is but little diminution or tapering;—perhaps about six inches: so that our admeasurements give, in that distance, an average thickness of two feet. Like the others with which it is associated, this trunk is flexuous; but is least so towards its superior part, for the last forty feet. Seventy feet of this fine stem are exposed within the limits of our drawing—we followed it several feet in the coal shale below the level surface without discovering any sign of termination. The specimens exhibited on the society's table were taken from that concealed portion. We may venture to assign a height of this tree of from eighty to one hundred feet. During the greatest portion of its entire length, a central longitudinal groove or depression appears, somewhat after the manner of some Stigmarias and Lepidodendrons. Like the other cases previously alluded to, such portions of the carbonized bark as remained on the trunk or mould, were extremely thin; readily scaling off, when dry. This bark was not more than from $\frac{1}{25}$ to $\frac{1}{30}$ of an inch in thickness. No traces of any other, or second bark, externally, has been observed in any specimen. A third trunk appears near the entrance to the gallery, this specimen exhibits more than fifty feet now uncovered, by coal or slate, we might judge, from its appearance, that it extended thirty or forty feet farther.

It is necessary to mention, that none of these trunks were in the extremely compressed state, such as is exhibited in those on the bottom slate. They occur as casts, filled with indurated clay. When fractured they break in rhomboids, whose acute angle is forty-three degrees. Longitudinal flutings are visible throughout the length of these stems, and obscure marks of cicatrices, of the smallest class, are of general occurrence.

There now remains only the important inquiry, under what class and family should these magnificent trunks be arranged? In the midst of certain obvious difficulties, we have not scrupled to class these dichotomous stems with the Sigillaires, and in that division which is now admitted among the tree ferns. We have even ventured to refer them to *Sigillaires elegans* or *hexagona*. With respect to the Sigillariæ which have bifurcations, M. Brongniart admits that they are confined to a single species, which species is the *Sigillaria elegans*. In this he is corroborated by M. Graeser, director of mines, who asserts that this character is frequent in that species.

With regard to the general form of the trunks of Sigillaria, their height, and their mode of termination, there is still very incomplete data. We have rarely had occasion

to follow these stems to a great extent. However, in the mine of Kunzwerk, M. Brongniart was able to measure one stem of Sigillaria, which laid parallel to the gallery of extraction; which stem was more than forty feet long. This stem diminished insensibly, from the base where it was one foot thick, to near the summit where it was only six inches, and there divided into two equal branches. I am not aware, that any fossil trees from the coal measures have ever been described, which at all approached to the dimensions of our Pennsylvania Sigillaria.

Respecting the admission of the Sigillaires into the family of the ferns, we have seen that Messrs. Lindley and Hutton entertain somewhat different views from M. Brongniart We have stated, with great brevity, the reasons which induce the last named naturalist to adhere to his classification; at the same time, to include therein one section under the name of *Caulopteris*, containing four species of undoubted arborescent ferns, and they are strikingly analogous to those which still actually exist. Of these four fossil arborescent ferns, one species, the Sigillaire *Cistii*, exists in the Coal Strata of Wilkesbarre, in this State. Fifty-five species of Sigillaria, besides the four of Caulopteris, occupy the coal formation. Many of these, perhaps all, are common both to Europe and to America.

That investigation has still to be followed up. On one point all are agreed:—that all the fossil plants, of whatever class, attained a magnitude vastly more considerable than the largest existing analogous species.

From the rocky covering of this and one or two adjacent coal seams, I have obtained specimens of *Lycopodium elegans;* one or two uncertain casts of *Sigillaria; Knorria imbricata?; Stigmaria ficoides; Lepidodendron*, two species; besides carbonized leaves and impressions of *Lycopodiolites*, in the grits and sandstones. *Calamites* are rare in this vicinity.

The discovery, not long ago announced by Mr. Logan, that the plant Stigmaria characterized, and almost universally prevailed in, the under clay of argillaceous floors of the coal seams of Europe, seems to hold good on this continent. On examination, any one can perceive that our lower shales, on which coal beds rest, are crowded with the stems and leaves of this singular plant. It was, however, further maintained that the floors alone, and not the roofs, contain the vestiges of these vegetables. I have not had much subsequent opportunity of satisfying myself on the latter point, since its announcement; but I think it is extremely probable: and that, in a great measure, the phenomena here agree with those developed by the European naturalist.

The drawing which accompanies this paper, and all the notes respecting the fossil plants, which were exhibited on seven or eight thousand square feet, having been completed prior to that announcement, I was desirous to see how far they were in conformity with Mr. Logan's system.

On examining this drawing, we shall perceive that only two specimens of Stigmaria occur in the entire length of the gallery. One of them is above the coal, on the north wall; the other is below the coal, on the south wall. This is certainly not a very satisfactory corroboration; but the plant overlying the coal may be a solitary individual, connected originally with the thin slaty covering of the coal: as, however, it appears by the sketch to have some of its leaves in close proximity, if not in direct contact with the stem, it has evidently not been removed from a distance, into the position in which we

observe it. It probably had been rooted in the thin slate seam, between the coal and the rock. A siliceous cast of a second stigmaria, apparently of another species, was obtained from the sandstone above. As similar sandstone casts of Stigmaria are among the commonest fossils found among the superficial debris of this carboniferous region, it can scarcely be maintained, with strict propriety, that these plants are limited to the soft argillaceous beds upon which the coal seams repose. Time and extended observation will determine the value of the rule. It will then perhaps be found that every bed of clay, embraced within the true limits of coal fields, contains a greater or less amount of these exuviæ; such clay being the natural position in which they grew and were sustained.

The following are the principal fossil plants referred to in the foregoing article. It is avowedly very incomplete;—an approximation, merely; and many are omitted

PLANTS IN THE ROOF OF THE COAL SEAM.

Sigillaria elegans, ...	A. Brongniart	pl. 146,—and pl. 158, fig. 1.
Stigmaria ficoides, ...	Sternberg	Tab. xii., also, some leaves.
Lycopodiolites elegans, ...	"	Tab. xvi., sandstone cast.
Knorria imbricata, ...	"	Tab. xxvii., sandstone above the conglomerate.
Lepidodendron—?—smaller than L. obovatum,	"	Tab. vi., cast in sandstone.
" " Volkmannianum, ...	"	Tab. liii., f. 3.

PLANTS IN THE UNDER CLAY OR FLOOR.

Sigillaria elegans, ...	A. Brongniart,	pl. 146, 158.
" elongata?	"	pl. 145, doubtful.
" lævigata, ...	"	pl. 143, $\frac{1}{3}$d larger than Brongniart's fig.
" pachydermata?	"	pl. 150, 2.
" reniformis?	"	pl. 142, doubtful.
Syringodendron? . no cicatrices visible, .	Sternberg.	
Stigmaria ficoides, ...	"	Tab. xii., with leaves in contact.
Sphenopteris delicatula, ...	A. Brongniart	pl. 58, fire clay outcrop.
" elegans, ...	Sternberg	Tab. xx, 3, 4, (second index,) Da.
Lepidodendron Volkmannianum, ...	Sternberg	Tab. liii., f. 3.
" rimosum, ...	"	Tab. x., very thick bark.
Nevropteris plicata, ...	"	Tab. xix., (second series.)
" Loshii, ...	A. Brongniart	pl. 73, fire clay outcrop.
Pecopteris long chitica?	"	pl. 84 and 128, outcrop.
" miltoni?	"	pl. 114, outcrop.
" cyathea, ...	"	pl. 101, "
Calamites Cistii, ...	"	pl. 20, "

ARTICLE IX.

Description of some new Fossil Shells, from the Tertiary of Petersburg, Virginia. By Henry C. Lea, Philadelphia. Read May 29, 1843.

In the United States, the various Supercretaceous, or Tertiary, formations, are widely extended and beautifully developed. They have been traced from the St. Lawrence to the Gulf of Mexico, and from the Atlantic far into the western territory. For the sake of convenience, geologists have divided them into two groups, according to their geographical position, namely, the Atlantic and the Western Tertiary. Of the latter it is not, at present, my intention to speak,—but little, comparatively, is known of it, and it presents a rich field to any enterprising geologist who may undertake its investigation.

The northern extremity of the Atlantic Tertiary, as far as it has been discovered, is on the St. Lawrence and around Lake Champlain. From thence to Maryland, its course may be traced by a few small patches in New Jersey, and, from Maryland to the Gulf of Mexico, it exists in a broad sheet.

It is to be expected that, extending as it does over so wide a space, it should present very different characters in different localities. Accordingly, we find that much confusion has existed in its classification. Mr. McClure, the first who attempted to systematize American geology, considered it all as alluvial, but subsequent geologists soon corrected this error. Mr. Conrad, in the first number of his "Fossil Shells of the Tertiary of North America," divided it into the Upper Marine, Middle Tertiary, and Lower Tertiary. In this arrangement, the Upper Marine corresponds very nearly with Mr. Lyell's Pliocene, the Middle Tertiary comprises the Miocene and Eocene of the same author, and the Lower Tertiary consists of sand and gravel containing Lignite and a few shells. Mr. Conrad has, more recently, adopted the classification of Lyell, which is perhaps best, as the beds comprising his Lower Tertiary are hardly of sufficient importance to constitute a separate formation.

The latest, and probably, most correct views upon this subject are, however, those which Mr. Conrad advances in the second number of the Bulletin of the National Institution. He there supposes that we possess the Eocene, Miocene, and Post-Pliocene, as nearly as the parallel can be drawn between our strata and those of Europe. Several links of the chain, however, appear to be wanting, as but one or two species are common to the Eocene and Miocene, and only recent shells have been found existing in both the Miocene and Post-Pliocene. The Eocene does not possess a single

species at present existing; in the Miocene the proportion is small; while, in the Post-Pliocene all are recent. According to Mr. Conrad, the per centage of still existing shells in the Miocene is about seventeen, but I am inclined to think that it will prove, on further investigation, to be smaller. It, however, cannot be relied on as a certain criterion, being extremely variable in different localities. Petersburg, Virginia, may be taken as an instance of one extreme: the following is a list of the fossils which have been found there, exclusive of those herein described.

Dentalium thallus,	Con.	Venus Rileyi,	Con.	Fissurella redimicula,	Say.
" attenuatum,	Say.	" difformis,	Say.	Crepidula fornicata,	"
Serpula granifera,	"	Cardium sub-lineatum,	Con.	" costata,	Morton.
Balanus sp.?		" laqueatum,	"	Dispotæa ramosa,	Con.
Pholas ovalis,	Say.	Cardita granulata,	Say.	Natica duplicata,	Say.
Panopæa reflexa,	"	Cypricardia arata,	"	" heros?	"
Mactra congesta,	Con.	Arca centenaria,	"	Acteon Wetherilli,	Lea.
Crassatella undulata,	Say.	" idonea,	"	Rotella nana,	"
" melina,	Con.	" incile,	"	Trochus philanthropus,	Con.
Corbula cuneata,	Say.	Pectunculus subovatus,	"	Turritella variabilis,	"
" inæqualis,	"	" quinquerugatus,	Con.	" indenta,	"
Tellina æquistriata,	"	" pulvinatus,*	Lamk.	" plebeia,	Say.
Lucina speciosa,	"	Nucula lævis,	Say.	Pleurotoma pyrenoides,	Con.
" contracta,	"	" obliqua,	"	Fasciolaria mutabilis,	"
" edentula,	"	Chama congregata,	Con.	Pyrula carica,	Say.
" divaricata,	Lamk.	" corticosa,	"	" canaliculata,	"
Astarte undulata,	Say.	Pecten eboreus,	"	Fusus cinereus,	"
" arata,	Con.	" Madisonius,	Say.	" exilis,	Con.
" concentrica,	"	Plicatula marginata,	"	Murex quadricostatus,	Say.
Clathrodon Grayi,	"	Perna torta,	"	Buccinum laqueatum,	Con.
Cytherea reposta,	"	Ostrea Virginiana? var.	Gmel.	" porcinum,	"
" convexa,	Say.	Capulus lugubris,	Con.	Marginella perpusilla,	"
Artemis acetabulum,	Con.			" limatula,	"

We have here sixty-eight species, in addition to one hundred and five which I shall describe in this paper, and which I consider as hitherto unknown, or in all, one hundred and seventy-three. Now, of these, but nine can be identified with existing shells, namely,

Lucina divaricata,	Crepidula fornicata,	Pyrula carica,
Artemis acetabulum,	Natica heros?	" canaliculata,
Ostrea Virginiana?	" duplicata,	Fusus cinereus.

and of these, two appear to me doubtful, namely, Natica heros, and Ostrea Virginiana. Considering them, however, as the recent species, this gives us about five per cent. of still existing shells. It appears almost absurd to compare this with the Miocene of Dax, the best characterized in Europe, which, by the tables of Dr. Grateloup, con-

* In the first number of the "Fossil Shells of the Tertiary of North America," Mr. Conrad has described and figured a shell as the Pect. pulvinatus, Lam. But, after comparing it with a number of specimens of that species, and with Deshayes' figures, I am forced to consider it as specifically distinct. I, therefore, propose to name it P. ELEPHANTOPUS.

tains between thirty and forty per cent. of recent shells. Yet the Miocene of Petersburg has not a single species which can be identified with any of the Claiborne Eocene fossils, while it abounds in shells which are found, at other localities, in company with more than twenty per cent. of recent species. These few facts will sufficiently exemplify the fallacy of attempting to classify our Tertiary by the rules which regulate that of Europe.

It may, perhaps, be deemed not irrelevant to this subject, to introduce here the following table of the number of the species in each genus, hitherto described from the Tertiary of the United States. Unfortunately great confusion exists in their synonymy, and he who would review the descriptions of them, with an impartial and unsparing hand, would confer a great benefit on all interested in American geology. To this part of the subject, I have not pretended to pay any attention, and therefore the number of species is, in reality, smaller than that given here, many of them being repeated under the same or different genera. I, however, have not felt inclined, at present, to undertake the Augean task of clearing away the synonymes, but I hope that, as far as I pretend to go, I shall be found correct; that is, as far as the mere numbers are concerned.*

List of the Fossil Shells found in the Tertiary Beds of the United States.

Genera.	No. of species.
Acteon,	23
Aligena,	2
Amphidesma,	12
Anatina,	3
Ancillaria,	7
Anolax,	2
Anomia,	1
Arca,	14
Artemis,	2
Astarte,	20
Avicula,	4
Balanus,	4
Bissomya,	1
Bonellia,	2
Buccinum,	20
Bulla,	5
Bullina,	1
Calyptrea,	4
Cancellaria,	17
Capulus,	1
Cardita,	6
Cardium,	7
Cassis,	1
Cemoria,	1
Cerithium,	10
Chama,	3
Chiton,	1
Conus,	5
Corbis,	3
Corbula,	11
Crassatella,	8
Crepidula,	12
Cryptostoma,	1
Cucullæa,	4
Cypræa,	1
Cumingia,	1
Cypricardia,	1
Cyrena,	1
Cytherea,	26
Delphinula,	12
Dentalium,	5
Diplodonta,	1
Dispotæa,	6
Donax,	1
Egeria,	10
Emarginula,	1
Erycina,	2
Fasciolaria,	5
Fissurella,	7
Fistulana,	1
Fulgur,	7
Fusus,	51
Gastrochæna,	1
Gnathodon,	3
Grateloupia,	1
Gryphæa,	1
Hiatella,	1
Hippagus,	1
Hipponix,	1
Infundibulum,	6
Isocardia,	2
Lepton?	1
Lima,	2
Littorina,	1
Lucina,	27
Lutraria,	2
Mactra,	18

* I regret that I have not been able to obtain the names of the species figured by M. Lesueur from the Eocene of Walnut Hill, Mississippi. I have seen the plates, but I do not know whether the descriptions were ever published. It may be seen that I have included in this catalogue the species described in the following pages.

Genera.	No. of species.
Marginella,	16
Melongena,	3
Mitra,	13
Modiola,	2
Monodonta,	1
Monoceros,	5
Monoptygma,	2
Murex,	6
Mya,	3
Myoparo,	1
Mysia,	2
Mytilus,	2
Nassa,	5
Natica,	23
Nautilus,	1
Nucula,	31
Nummulites,	1
Oliva,	16
Orbicula,	1
Orbis,	1
Ostrea,	18
Pandora,	2
Panopæa,	4
Pasithea,	21
Patella,	1
Pecten,	22
Pectunculus,	22
Perna,	2
Petaloconchus,	1
Petricola,	3
Pholadomya,	2
Pholas,	5
Placuna,	1
Plagiostoma,	1
Planaria,	1
Pleurotoma,	32
Plicatula,	4
Proto,	1
Psammobia,	2
Psammocola,	2
Pyramidella,	3
Pyrula,	7
Ranella,	1
Rostellaria,	4
Rotella,	5
Saxicava,	2
Sanguinolaria,	2
Scalaria,	16
Serpula,	5
Sigaretus,	5
Siliquaria,	2
Solarium,	18
Solen,	2
Solecurtis,	2
Spirorbis,	1
Stalagmium,	1
Strigilla,	1
Tellina,	9
Terebra,	8
Teredo,	4
Thracia,	1
Triton,	1
Trochus,	16
Tuba,	3
Turbinella,	5
Turritella,	20
Typhis,	2
Venericardia,	7
Venerupis,	1
Venus,	11
Vermetus,	1
Voluta,	12
Volvaria,	1

It is to the kindness of Mr. Tuomey, of Petersburg, that I owe the following shells, as well as those in the list a few pages back. Most of the smaller species herein described, I met with by carefully examining the sand scraped from the cavities of larger shells, as well as a small portion of the marl of the vicinity, with which Mr. Tuomey was kind enough to favor me. I mention this merely to show the importance of thoroughly searching the strata of the various localities before we conclude that we have all the species existing there. Attracted by the beauty of the larger shells, conchologists have very much neglected the more minute ones, which require a closer examination, and thus our knowledge of our fossil conchology is still limited. I may as well observe here, that I found the species met with in the sand from the cavities of the larger shells, in general, different from those in the loose marl. It is difficult to give a reason for this, unless there were species which usually inhabited the interior of dead shells, like the recent Valvata tricarinata, Say.

In looking over these shells, I have been struck with the general resemblance which obtains between them and those of a corresponding age from Dax. This is peculiarly observable in the genera Acteon, Pasithea, &c. which are very numerous in both localities. Their connexion is so close that in some cases they are scarce specifically distinct.

FAMILY SERPULIDÆ.

GENUS SERPULA.

S. CONVOLUTA, PL. 34. FIG. 1.

S. testâ in spiram discoidalem contortâ, tenui, plerumque cancellatâ, apud apicem regulariter volutâ; aperturâ rotundâ.
Shell twisted into a discoidal spire, thin, usually cancellate, regularly whorled near the apex; mouth round.

Diam. .10 of an inch.

Remarks.—This shell is generally twisted into a regular disc. The sculpture is very variable, sometimes seeming like longitudinal moniliferous costæ, and, at others, regularly cancellate. The apex is singularly formed, being smooth and perfectly voluted, like a young Turbo. This is, I suppose, the form it has when excluded from the egg.

S. ANGUINA, PL. 34. FIG. 2.

S. testâ minimâ, irregulariter contortâ, striatâ, crassâ; striis irregularibus transversis; aperturâ rotundâ.
Shell very small, irregularly twisted, striate, thick; striæ irregular, transverse; mouth round.

Diam. .04 of an inch.

Remarks.—This is a very minute species, and is, I believe, the only one of our fossil Serpulæ that has no longitudinal lines on the surface. This character will readily distinguish it from others. The apex has the same voluted character as the last, although not as well developed.

GENUS PETALOCONCHUS,* (NOBIS.)

Testa tubularis, solida, irregulariter contorta, laminis longitudinalibus duabus internis.
Shell tubular, solid, irregularly twisted, with two internal longitudinal plates.

Remarks.—The singular shell, on which I propose to found the above genus, differs from all the known tubular shells that I have met with, in the two internal longitudinal plates. It may possibly belong to the family Scalaridæ, and, if so, presents a link between them and the Plicacidæ.

P. SCULPTURATUS, PL. 34. FIG. 3.

P. testâ vel contortâ vel turritâ, crassâ, costulis longitudinalibus noduliferis; laminis internis politis, lævibus, ad aperturam obsoletis; aperturâ rotundâ.
Shell sometimes twisted, sometimes turrited, thick, with small longitudinal noduliferous ribs; internal laminæ smooth, polished, obsolete at the mouth; mouth round.

Diam. .20 of an inch.

Remarks.—The longitudinal costæ are generally nodulous, but they occasionally seem rather to be cancellated by transverse sulci, which, in other specimens, appear to usurp their place. The two internal laminæ are placed at about one-sixth of the circumference apart. They are generally directed towards the centre, and sometimes nearly meet. In some specimens they are much smaller than in others. They rarely or never seem to be continued to the aperture.

This is a very variable shell, both as to the sculpture and internal plates. I at first

* A πέταλον, lamina, et κόγχος, concha.

thought that there were two or three distinct species, but the varieties glide imperceptibly into each other. It appears to be by no means an uncommon shell at Petersburg.

The form figured is a very usual one. I have but few specimens which do not exhibit a decided tendency to form regular revolutions, and in some, the axis is so straight that a pin may be thrust through the umbilicus from the apex to the base.

The second figure is a specimen fractured to exhibit the appearance of the laminæ.

FAMILY TUBICOLIDÆ.

GENUS TEREDO.

T. CALAMUS, PL. 34. FIG. 4.

T. testâ incognitâ; tubo parvo, rotundo, tenui, rugoso, striis irregularibus transversis.

Shell unknown; tube small, round, thin, rugose, with irregular transverse striæ.

Diam. .08 of an inch.

Remarks.—I found several specimens of this little species of Teredo, on breaking open a mass of Madrepore which they had pierced. It differs from the following shell, principally, in being much smaller, thinner, and more rugose.

T. FISTULA, PL. 34. FIG. 5.

T. testâ incognitâ; tubo rotundo, tereti, crassissimo, tum recto tum curvato; striis irregularibus transversis raris.

Shell unknown; tube round, terete, very thick, sometimes straight and sometimes curved; with a few irregular transverse striæ.

Diam. .50 of an inch.

Remarks.—The transverse lines of growth vary exceedingly both in size and direction. The substance of the shell is very thick, the outer diameter being frequently .50, while that of the aperture is about .28 of an inch. I have them, however, even thicker.

GENUS GASTROCHÆNA.

G. LIGULA, PL. 34. FIG. 6.

G. tubo incognito; testâ transversâ, oblanceolatâ, valdè inæquilaterali, posticè rotundatâ, anticè acuminatâ, inflatâ, concentricè striatâ; striis parvis, irregularibus; anticè hiatu maximo, valdè obliquo; margine basali tortuoso; margine dorsali recto; margine antico brevissimo; natibus sub-prominulis.

Tube unknown; shell transverse, oblanceolate, very inequilateral, rounded posteriorly, acuminate anteriorly, inflated, concentrically striate; striæ small, irregular; anteriorly gaping widely and very obliquely; basal margin tortuose; dorsal margin straight; anterior margin very short; beaks somewhat prominent.

Diam. .15 of an inch. Length .28. Breadth .12.

Remarks.—The opening at the anterior extremity commences near the dorsal margin, and extends to about the middle of the base. The beaks are placed very near the anterior end of the shell. As in most Gastrochænæ, there is a small interior cuneiform process immediately under them.

In procuring several specimens of this shell from a piece of madrepore which they had pierced, I unfortunately broke the tubes, and am therefore unable to describe them.

This species is not unlike the G. truncata, Sowerby, a recent shell from Panama, but may be distinguished by its smaller size, rounded extremity, and longer opening. It is,

I believe, the first species of the genus as yet discovered in a fossil state in this country. Mr. Conrad mentions having found the Fistulana elongata, Lam. at Claiborne, but, upon comparison with M. Deshayes' figure of that shell, I do not think that it can be identical with the present species. It is larger, more twisted, and has a different sculpture on the anterior part.

The genus Gastrochæna, as formed by Lamarck, was placed among the Pholadidæ, and considered to have no tube. M. Deshayes, however, includes it in the genus Fistulana, as it inhabits a tube and has no teeth. Mr. Sowerby, again, considers as Gastrochænæ those species which have a bent tube and an oval shell. According to this arrangement, the present species would, most probably, come under this genus, and as such I have placed it.

There are two Gastrochænæ among the fossils of Great Britain, one from the Oolite, the other from the London Clay. Deshayes describes five from the Paris Basin.

FAMILY PHOLADIDÆ.

GENUS PHOLAS.

P. RHOMBOIDEA, PL. 34. FIG. 7.

P. testâ transversâ, obliquè rhomboideâ, valdè inæquilaterali, posticè rotundato-angulatâ, anticè rostratâ, inflatâ, tenui, medio divisâ lineâ impressâ; areâ posticâ striis lævibus concentricis; areâ anticâ striis acutis flexuosis concentricis; margine basali curto; margine dorsali recto, valdè reflexo; palmulâ parvâ, recurvâ, tenui; lineis internis duabus elevatis longitudinalibus.

Shell transverse, obliquely rhomboidal, very inequilateral, rounded-angular posteriorly, rostrate anteriorly, inflated, thin, divided in the middle by an impressed line; posterior area with smooth concentric striæ; anterior area with acute, flexuose, concentric striæ; basal margin short; dorsal margin straight, very much reflected; palmule small, recurved, thin; two longitudinal internal, elevated lines.

Diam. .20 of an inch. Length .28. Breadth .18.

Remarks.—The striæ on the anterior part of the shell are sometimes wrinkled so regularly that they give it the appearance of being cancellate, although there are no radiating lines. The posterior part of the shell is nearly smooth, from the dividing line to the umbonial slope, where there are numerous regular lines of growth. There is a kind of second dentiform process, immediately below the beaks, formed by the recurving of the upper termination of the posterior margin. The two internal striæ extend from the beaks to the base. The posterior one is situated immediately under the umbonial slope. The anterior one is caused by the impressed dividing line. It extends, in a point, a little beyond the basal margin.

This shell is very similar to a specimen of the P. ovalis, Say, without the tube, and with the thin anterior basal portion removed, but I believe it to be a perfect shell, as I obtained it myself from the hole which it had formed, and in which it appeared to have remained undisturbed. It was surrounded by a little indurated mud which preserved it entire. It seemed to be entirely destitute of a tube, which character separates it from the P. ovalis. It also differs in the shape and size of the palmule, and in the two internal lines.

FAMILY SOLENIDÆ.

GENUS SOLEN.

S. MAGNODENTATUS, Pl. 34. Fig. 8.

S. testâ anticè truncatâ, et valdè hiante, lævi, politâ, crassâ; natibus compressis; dente laterali uno; dente cardinali uno, longo, acuto.

Shell truncate, and gaping very much anteriorly, smooth, polished, thick; beaks compressed; with one lateral, and one long, acute, cardinal tooth.

Diam.— . Length— . Breadth— .

Remarks.—Although I possess but a small fragment of this shell, yet it differs so essentially in the teeth from all of our Solenes, that I have no hesitation in pronouncing it distinct. I believe that it is the only extinct fossil species as yet found in our Tertiary.

GENUS PANOPÆA.

P. DUBIA, Pl. 34. Fig. 9.

P. testâ quadrato-ellipticâ, transversâ, inæquilaterali, posticè truncatâ, anticè rotundatâ, sub-inflatâ, crassiusculâ, striatâ; striis concentricis, regularibus; margine basali recto; margine dorsali recto; nymphis magnis, exsertis, longissimis; cardine cochleâ parvâ.

Shell quadrately elliptical, transverse, inequilateral, posteriorly truncate, anteriorly rounded, somewhat inflated, rather thick, striate; striæ concentric, regular; basal margin straight; dorsal margin straight; beaks prominent; nymphæ large, exserted, very long; hinge with a small fosset.

Diam. .10 of an inch. Length .08. Breadth— .

Remarks.—The nymphæ are unusually large, much exserted, and very long, extending the whole length of the dorsal margin. Near the beak, they are suddenly depressed and twisted round, and terminate in a small, shallow, internal fosset, or spoon-shaped tooth.

It is not without some hesitation that I have placed this shell among the Panopææ, as it has a spoon-shaped tooth in place of an erect, pointed one, but there is no genus to which it can be said positively to belong, and I do not consider its peculiar characters sufficient to authorize the erection of a new one for its reception. It seems to connect the Glycymeris with the Anatina, having the nymphæ of the one, and the spoon-shaped tooth of the other.

FAMILY MYIDÆ.

GENUS MYA.

M. REFLEXA, Pl. 34. Fig. 10.

M. testâ quadrilaterali, sub-inæquilaterali, posticè rotundatâ, anticè truncatâ et valdè apertâ, inflatâ, striatâ; striis concentricis, irregularibus; clivo umboniali elevato, rotundato; margine basali curvato; margine dorsali arcuato; natibus prominentibus, incurvis.

Shell quadrilateral, somewhat inequilateral, rounded posteriorly, truncate and very open anteriorly, inflated, striate; striæ concentric, irregular; umbonial slope elevated, rounded; basal margin curved; dorsal margin arcuate; beaks prominent, incurved.

Diam. .18 of an inch. Length .22. Breadth .29.

Remarks.—The opening at the anterior portion of the shell is remarkably large, and the margin there appears to be somewhat reflected. The striæ are more numerous and better characterized at the extremities, than in the central portion of the shell.

As but one valve of this shell, and that the left one, is before me, I cannot determine the shape of the tooth. The pit to receive it is small and almost horizontal.

This is, I believe, the only extinct species of Mya as yet found in our Tertiary.

GENUS THRACIA, (LEACH.)

T. TRANSVERSA, PL. 34. FIG. 11.

T. testâ sub-ellipticâ, valdè inæquilaterali, posticè acuminato-rotundatâ, anticè truncatâ, sub-compressâ, tenui, medio lævi, posticè et anticè concentricè striatâ; clivo umboniali rotundato; margine basali curvato; margine dorsali medio angulato, posticè convexo, anticè concavo; natibus sub-acutis; callo nymphali parvo, obliquo.

Shell sub-elliptical, very inequilateral, acuminately rounded posteriorly, truncate anteriorly, sub-compressed, thin, smooth centrally, striate posteriorly and anteriorly; umbonial slope rounded; basal margin curved; dorsal margin angular in the middle, posteriorly convex, anteriorly concave; beaks somewhat acute; nymphal callosity small, oblique.

Diam. .10. Length .18. Breadth .28 of an inch.

Remarks.—From the shape of the anterior margin, I conclude that the shell must have gaped considerably there, but as I have no pair of valves, I cannot be certain. The sinus of the palleal impression is deep, and near the anterior cicatrix. In this character, it differs from the rest of the genus.

This is, I believe, the first Thracia found in our Tertiary deposites. Deshayes, in his tables, gives four as the number of European Tertiary species. The present one is the smallest of the genus.

GENUS ANATINA.

A. TELLINOIDES, PL. 34. FIG. 12.

A. testâ ovato-triangulari, transversâ, posticè angulatâ, anticè rotundatâ, compressâ, posticè undulatâ, tenui, concentricè striatâ; striis crebris minutis; margine basali sub-flexuoso; natibus compressis, prominentibus; dentibus lateralibus magnis; cochleâ obliquâ, ovato-acuminatâ, minimè profundâ; cicatricibus magnis.

Shell ovate-triangular, transverse, angular posteriorly, rounded anteriorly, compressed, posteriorly undulate, thin, concentrically striate; striæ numerous, minute; basal margin slightly flexuose; beaks compressed, prominent; lateral teeth large; fosset oblique, ovate-acuminate, shallow; cicatrices large.

Diam. .25. Length .45. Breadth —— of an inch.

Remarks.—Of the lateral teeth, the posterior one is much the longer. The fosset is small, quite oblique, acute above and rounded below. The broad undulation on the posterior part of the shell gives it very much the appearance of a Tellina, when viewed externally. The lines of growth are small, very numerous and irregular.

This species is quite thin and fragile. Out of some half a dozen specimens, I have but one perfect valve, and that is a very young one. I am therefore unable to give all the dimensions.

Judging from description, this shell is not unlike the A. antiqua, Conrad, but the difference in size and sculpture, and the posterior undulation distinguish them at once.

FAMILY MACTRIDÆ.

GENUS ALIGENA, (Nobis.)

Testa æquivalvis? subæquilateralis, posticè et anticè clausa; cardo dente cardinali uno, sulco sub natibus longo, minimè profundo.

Shell equivalve? sub-equilateral, closed posteriorly and anteriorly; hinge with one cardinal tooth, and a long shallow sulcation under the beaks.

Remarks.—The cardinal tooth is, in general, rather small. The sulcus appears to have received the ligament. It commences at the beak, and runs obliquely past the dorsal margin into the cavity under the beak. As I possess only odd valves of both the following species, I am unable to determine whether the shell is equivalve or not.

I have in vain endeavoured to find some genus, already described, which might receive these little shells, but their peculiar characters in having one cardinal tooth, and a ligamentiferous sulcation, descending into the shell, distinguish them from other genera. Their place in the systems is, most probably, in the family Mactridæ, between Erycina and Ungulina.

I have called the genus, Aligena, one of the surnames of Venus, from its resemblance to Erycina, also an appellation of that goddess.

A. striata, Pl. 34. Fig. 13.

A. testâ transversâ, sub-ellipticâ, posticè et anticè rotundatâ, inflatâ, tenui, striatâ; striis concentricis, propè marginem basalem maximis; clivo umboniali elevato, sub-angulato; margine basali curvato; margine dorsali medio angulato, posticè et anticè curvato; natibus prominentibus, incurvis, sub-lævibus; dente cardinali minimo; sulco longo, pene transverso; margine interno integro.

Shell transverse, sub-elliptical, rounded anteriorly and posteriorly, inflated, thin, striate; striæ concentric, very large near the basal margin; umbonial slope elevated, somewhat angulate; basal margin curved; dorsal margin angular in the middle, curved posteriorly and anteriorly; beaks prominent, incurved, nearly smooth; cardinal tooth very small; sulcation long, nearly transverse; margin entire within.

Diam. .10. Length .19. Breadth .21 of an inch.

Remarks.—The concentric striæ are irregular in size and number, but there is a general increase from the beaks to the base. Those near the base, indeed, almost merit the name of costæ. The cardinal tooth is extremely small.

A. lævis, Pl. 34. Fig. 14.

A. testâ transversâ, sub-quadrilaterali, posticè rotundatâ, anticè subtruncatâ, convexâ, inflatâ, lævi; margine basali recto; margine dorsali medio angulato, posticè et anticè curvato; natibus sub-prominulis, incurvis; dente cardinali longo; sulco lato, curto, penè transverso; margine interno integro.

Shell transverse, sub-quadrilateral, posteriorly rounded, anteriorly sub-truncate, convex, inflated, smooth; basal margin straight, dorsal margin angular in the middle, curved anteriorly and posteriorly; beaks somewhat prominent, incurved; cardinal tooth long; sulcation wide, short, nearly transverse; margin entire within.

Diam. .14. Length .18. Breadth .22 of an inch.

Remarks.—There are a few, almost imperceptible lines of growth over the surface of the shell, which, under a powerful microscope, give it a somewhat roughened appearance. The cardinal tooth is very long, and the sulcus is shallow, so that the hinge, at first glance, is not unlike that of the genus Thracia.

This shell is closely allied to the preceding, but the differences in outline, hinge and sculpture separate them.

FAMILY LITHOPHAGIDÆ.

GENUS PETRICOLA.

P. COMPRESSA, PL. 34. FIG. 15.

P. testâ valdè transversâ, valdè inæquilaterali, sub-elliptică, compressâ, posticè sub-truncatâ, anticè rotundatâ, tenui, striatâ posticè et anticè; striis minimis, concentricis; margine basali recto; margine dorsali recto; natibus sub-acutis, prominentibus; dentibus duobus, parvis, divergentibus.

Shell very transverse, very inequilateral, sub-elliptical, compressed, posteriorly sub-truncate, anteriorly rounded, thin, striate posteriorly and anteriorly; striæ very small, concentric; basal margin straight; dorsal margin straight; beaks somewhat acute, prominent; teeth two, small, divergent.

Diam. .10. Length .12. Breadth .25 of an inch.

Remarks.—The concentric lines of growth are very small. They are visible on the anterior and posterior portions of the shell. On the central part they are obsolete, leaving it smooth. The teeth are small and unusually divergent for a Petricola.

This shell is smaller and more compressed than any of our described species. In form it much resembles Saxicava vaginoides, Desh., but it is more transverse and differs in the hinge.

FAMILY NYMPHIDÆ.

GENUS PSAMMOCOLA, (BLAINVILLE.)

P. LUCINOIDES, PL. 34. FIG. 16.

P. testâ sub-orbiculari, pene æquilaterali, posticè et anticè rotundatâ, convexâ, tenui, striatâ; striis concentricis, minimis; natibus prominentibus, sub-rectis; valvâ sinistrâ dentibus duobus cardinalibus, quorum unus bifidus, lateralibus nullis.

Shell suborbicular, almost equilateral, rounded anteriorly and posteriorly, convex, thin, striate; striæ concentric, very small; beaks prominent, nearly straight; left valve with two cardinal teeth, one of which is bifid, and no lateral ones.

Diam. .15. Length .31. Breadth .35 of an inch.

Remarks.—This shell is unusually lenticular for a Psammocola. The concentric striæ are numerous and extremely small. There are, however, three or four larger ones, nearly equidistant, over the surface of the shell.

The general resemblance which this shell bears to some species of the genus Lucina, will readily distinguish it from its congeners.

I have adopted this genus on the authority of Sowerby, who says that in it Blainville unites the Psammobia and Psammotæa of Lamarck, considering the difference between these genera as artificial and accidental.

P. REGIA, PL. 34. FIG. 17.

P. testâ transversâ, ovato-quadratâ, inæquilaterali, posticè hiante, anticè et posticè subtruncatâ, valdè inflatâ, crassissimâ, sulcatâ; sulcis radiantibus, crebris, æqualibus, latis; margine basali penè recto; margine dorsali sub-cur-

vato; natibus valdè elevatis, acuminatis; in valvâ utrâque dentibus cardinalibus duobus, lateralibus nullis; nymphis curtis, crassis; lunulâ parvâ, cordatâ; cicatricibus maximis; cicatrice palleali valdè sinuato.

Shell transverse, ovately quadrate, inequilateral, gaping posteriorly, subtruncate anteriorly and posteriorly, very much inflated, very thick, sulcate; sulci radiating, numerous, equal, wide; basal margin almost straight; dorsal margin slightly curved; beaks much elevated, acuminate; hinge in each valve with two cardinal and no lateral teeth; nymphæ short, thick; lunule small, cordate; cicatrices very large; palleal impression much sinuated.

Diam. 1.25. Length 1.56. Breadth 2.30 inches.

Remarks.—The radiating sulci are largest and deepest on the posterior extremity of the shell; they are interrupted by occasional lines of growth. The palleal impression becomes very broad as it approaches the anterior cicatrix. It is very rugose, and has a large, semi-elliptical sinus posteriorly. In the right valve, one of the teeth is bifid, but, as in all my specimens the hinge of the left valve is fractured, I am unable to say whether this be the case in it or not. The outline of the shell is very variable. I have one specimen which is nearly oblong, with a sinuated basal margin and almost central beaks. In this form its external appearance approaches closely that of the Arca centenaria of Say.

Judging from description, this shell must resemble the Petricola centenaria, Conrad, but its nymphæ, teeth and sinuated palleal impression, exclude it from that genus. It is larger and more beautiful than any of its congeners.

GENUS LUCINA.

L. PUNCTULATA, PL. 34. FIG. 18.

L. testâ rotundâ, lenticulari, sub-æquilaterali, posticè et anticè truncato-rotundatâ, convexâ, tenui, diaphanâ, punctulatâ, substriatâ; striis concentricis, irregularibus, raris; clivo umboniali rotundato; natibus prominentibus, acutis; valvâ sinistrâ dentibus cardinalibus duobus, laterali uno; margine interno integro.

Shell rounded, lenticular, sub-equilateral, truncately rounded posteriorly and anteriorly, convex, diaphanous, punctulate, somewhat striate; striæ concentric, few, irregular; umbonial slope rounded; beaks prominent, acute; left valve with one lateral and two cardinal teeth; internal margin entire.

Diam. .16. Length .32. Breadth .35 of an inch.

Remarks.—The concentric lines of growth are, for the most part, very small, but there are two or three larger ones. The punctulations extend over the whole surface. They are very small, and cannot be seen without the aid of a microscope, but they impart a rough feeling to the shell when handled.

This shell may be readily distinguished from all its fossil congeners by its diaphanous substance and punctulate surface.

L. LENS, PL. 34. FIG. 19.

L. testâ orbiculari, æquilaterali, valdè convexâ, crassâ, costatâ; costis concentricis, parvis, crebrissimis, planulatis, politis; margine dorsali flexuoso; natibus prominentibus, acutis, incurvis; lunulâ ellipticâ, magnâ, profundâ; dentibus in utrâque valvâ, cardinalibus duabus parvis, lateralibus duabus magnis; margine interno minutè crenulato.

Shell orbicular, equilateral, very convex, thick, costate; costæ concentric, small, very numerous, flattened, polished; dorsal margin flexuose; beaks prominent, acute, incurved; lunule elliptical, large, deep; each valve with two small cardinal, and two large lateral teeth; internal margin minutely crenulate.

Diam .28. Length .35. Breadth .38 of an inch.

Remarks.—The ribs are very small, and appear like striæ, unless examined with a microscope. There are occasional larger ones, where the shell appears to have ceased

growing for awhile, and some are minutely wrinkled. The cicatrices are deep and well defined. The whole shell is remarkably globose.

This species agrees pretty well with the description of S. trisulcata, Conrad, but that shell is said to be "obovate," while ours is very rotund. It is also closely allied to some of its congeners from Claiborne.

FAMILY CONCHIDÆ.

GENUS ASTARTE.

A. LINEOLATA, PL. 34. FIG. 20.

A. testâ triangulari, pene æquilaterali, inflatâ, crassâ, striatâ; striis crebrissimis, rotundatis, concentricis; margine basali sub-curvato; natibus elevatis, acuminatis; lunulâ valdè elongatâ; dentibus magnis, valdè divergentibus; margine interno crenulato.

Shell triangular, almost equilateral, inflated, thick, striate; striæ concentric, very numerous, rounded; basal margin somewhat curved; beaks elevated, acuminate; lunule much elongated; teeth large, very divergent; internal margin crenulate.

Diam. .15. Length .18. Breadth .21 of an inch.

Remarks.—The striæ are very regular, minute, and about fifty in number, on a full-grown specimen now before me. The lunule is unusually long and rather broad. The beaks are elevated and produced.

I, at first, regarded this as a young specimen of A. concentrica, Conrad, but the crenulations on the inner margin prove it to be full-grown. In size it approaches the A. lunulata, Con., but the striæ are much smaller and more numerous, and the shell is more inflated.

GENUS CYTHEREA.

C. ELEVATA, PL. 34. FIG. 21.

C. testâ ovatâ, transversâ, inæquilaterali, posticè subtruncatâ, anticè rotundato-angulatâ, inflatâ, crassâ, nitente, substriatâ; striis concentricis, minimis, medio obsoletis; margine basali curvato; margine dorsali angulato; natibus elevatis, prominentibus; dentibus magnis, quorum uno bifido.

Shell transverse, ovate, inequilateral, subtruncate posteriorly, rounded-angular anteriorly, inflated, thick, shining, substriate; striæ concentric, very small, obsolete in the middle; basal margin curved; dorsal margin angular; beaks elevated, prominent; teeth large, one bifid.

Diam. .19. Length .28. Breadth .32 of an inch.

Remarks.—There are no very decided characters about this shell, yet I cannot refer it to any known species. When young, its form is more longitudinal. It is more allied to C. convexa, Say; than to any other shell.

C. SPHÆRICA, PL. 34. FIG. 22.

C. testâ rotundâ, æquilaterali, globosâ, tenui, lævi, politâ; margine dorsali curvato; natibus elevatis, prominentibus, rectis lunulâ minimâ, lanceolatâ; dentibus parvis.

Shell rotund, equilateral, globose, thin, smooth, polished; dorsal margin curved; beaks elevated, prominent, straight; lunule very small, lanceolate; teeth small.

Diam. .18. Length .19. Breadth .20 of an inch.

Remarks.—This shell is rounded and more globose than any of its congeners that I have seen. These characters will serve to distinguish it from all our other fossil species.

GENUS VENUS.

V. ASCIA, PL. 34. FIG. 23.

V. testâ longitudinali, obliquè triangulari, sub-inæquilaterali, posticè et anticè sub-angulatâ, compressâ, crassâ, striatâ; striis concentricis raris; margine basali minimè curvato; margine dorsali angulato; natibus prominentibus, acutis; dentibus tribus divergentibus; cicatrice palleali acutè sinuata; lunulâ magnâ, elevatâ, lineâ impressâ marginatâ.

Shell longitudinal, obliquely triangular, sub-inequilateral, somewhat angular posteriorly and anteriorly, compressed, thick, striate; striæ concentric, few; basal margin slightly curved; dorsal margin angular; beaks prominent, acute; teeth three, diverging; palleal impression acutely sinuate; lunule large, elevated, margined with an impressed line.

Diam. .15. Length .30. Breadth .31 of an inch.

Remarks.—The surface is somewhat rugulose with irregular lines of growth, which, in two or three places, amount almost to ribs. The general outline is that of a triangle with slightly curved sides.

This shell has an unusual shape for a Venus, but the three distinct cardinal teeth will not admit it into any other genus. Although the sinus of the palleal impression is deep and acute, it has not the circular outline of the Artemis.

FAMILY CARDIIDÆ.

GENUS HIATELLA.

H. LANCEA, PL. 34. FIG. 24.

H. testâ transversissimâ, inæquilaterali, posticè et anticè truncato rotundatâ, minimè hiante, valdè compressâ, concentricè striatâ; striis minimis; clivo umboniali elevato; margine basali recto; margine dorsali medio sub angulato, posticè et anticè recto; natibus prominentibus; dentibus magnis.

Shell very transverse, inequilateral, truncately rounded posteriorly and anteriorly, gaping very slightly, very much compressed, concentrically striate; striæ very small; umbonial slope elevated; basal margin straight; dorsal margin sub-angular in the middle, straight posteriorly and anteriorly; beaks prominent; teeth large.

Diam. 10. Length .15. Breadth .29 of an inch.

Remarks.—The lines of growth are very small and inconspicuous. The two teeth in the left valve diverge considerably. The anterior one is bifid.

This genus is placed in the family Cardiidæ by Lamarck, and in the Lithophagidæ by Sowerby, who does not regard it as distinct from Saxicava. Which is right, I have no means of determining, and I therefore leave it where Lamarck places it.

FAMILY ARCACIDÆ.

GENUS NUCULA.

N. DOLABELLA, PL. 34. FIG. 25.

N. testâ obliquè triangulari, inæquilaterali, posticè et anticè angulatâ, inflatâ, crassiusculâ, striatâ; striis concentricis, minutissimis; striis longitudinalibus, pene obsoletis, raris, clivo umboniali precipiti; margine basali curvato; margine dorsali medio acutè angulato, posticè et anticè recto; dentibus parvis; cochleâ parvâ, sub triangulari; margine interno crenulato.

Shell obliquely triangular, inequilateral, posteriorly and anteriorly angulated, inflated, rather thick, striate; concentric striæ very small; longitudinal striæ, few, almost obsolete; umbonial slope steep; basal margin curved; dorsal margin acutely angular in the middle, posteriorly and anteriorly straight; teeth small; fosset small, sub-triangular; internal margin crenulate.

Diam .17. Length .18. Breadth .20 of an inch.

Remarks.—The longitudinal striæ are only visible in a strong light, with a powerful microscope. The concentric lines of growth are also small, with the exception of two or three larger ones.

This may prove to be only a variety of N. obliqua, Say, but it differs from all my specimens of that shell in being more inequilateral and inflated, in the form of the fosset, and in the straight series of teeth.

N. DIAPHANA, PL. 34. FIG. 26.

N. testâ transversâ, inæquilaterali, sub-ellipticâ, posticè et anticè rotundatâ, inflatâ, diaphanâ, tenui, lævi, politâ, intus margaritaceâ; clivo umboniali sub planulato; margine basali curvato; margine dorsali curvato; natibus prominentibus; dentibus valdè arcuatis, anticis quinque, posticis duodecim; cochleâ rhomboideâ, obliquâ; margine interno crenulato.

Shell transverse, inequilateral, sub-elliptic, rounded anteriorly and posteriorly, inflated, diaphanous, thin, smooth, polished, pearly within; umbonial slope somewhat flattened; basal margin curved; dorsal margin curved; beaks prominent; teeth very arcuate, five anterior, twelve posterior; fosset rhomboidal, oblique; internal margin crenulated.

Diam. .04. Length .11. Breadth .15 of an inch.

Remarks.—This little shell, in common with the preceding, has some resemblance to the N. obliqua, Say, but it may be distinguished by its elliptical shape, thin and diaphanous substance, smooth surface, and rhomboidal fosset. The teeth are also more arcuate, and there is a greater disparity between the posterior and anterior series.

In outline, this species is closely allied to the N. antiqua, Mighels and Adams, from the Post-Pliocene of Massachusetts.

N. ÆQUILATERA, PL. 34. FIG. 27.

N. testâ longitudinaliter-ellipticâ, æquilaterali, posticè et anticè sub-curvatâ, inflatâ, crassâ, punctato-costatâ; costis radiantibus, vel punctiferis vel cancellatis; margine basali valdè curvato; margine dorsali angulato; natibus prominulis, incurvis, rectis; dentibus parvis, rectis, anticis tribus, posticis octo; cochleâ parvâ, profundâ; margine interno crenulato.

Shell longitudinally elliptical, equilateral, somewhat curved posteriorly and anteriorly, inflated, thick, punctately costate; costæ small, radiating, punctiferous or cancellate; basal margin very much curved; dorsal margin angulate; beaks somewhat prominent, incurved, straight; teeth small, straight, three anterior, eight posterior; fosset small, deep; margin crenulate within.

Diam. .08. Breadth .10. Length .12 of an inch.

Remarks.—The ribs are small, sometimes divaricate, and punctulate. They occasionally have the appearance of being cancellate. The shorter series of teeth is immediately under the beaks and adjoining the fosset, from which the longer series is removed by a smooth intervening space. This character, and the longitudinal equilateral shape seem to remove it from the genus Nucula, but they can hardly be said to amount to generic distinctions.

This shell bears a general resemblance to the Myoparo costatus, Lea, but its shape does not admit it into that genus.

N. CARINATA. PL. 34. FIG. 28.

N. testâ transversâ, ovato-acuminatâ, subinæquilaterali, anticè rostratâ, posticè rotundatâ, inflatâ, crassiusculâ, concentricè sulcatâ; sulcis parvis, crebris, regularibus, rotundatis; clivo umboniali elevato, carinato; margine basali curvato; margine dorsali medio angulato, posticè convexo, anticè concavo; natibus minimè elevatis, recurvis; dentibus angulatis, carinatis; anticis quatuordecim, posticis quindecim; cochleâ triangulari, profundâ; margine interno integro.

Shell transverse, ovate-acuminate, sub-inequilateral, anteriorly rostrate, posteriorly rounded, inflated, rather thick, concentrically sulcate; sulci small, numerous, regular, rounded; umbonial slope elevated, carinate; basal margin curved; dorsal margin angular in the middle, posteriorly convex, anteriorly concave; beaks very slightly elevated, recurved; teeth angular, carinate, fourteen anterior, fifteen posterior; fosset triangular, deep; internal margin crenulate.

Diam. .15. Length .18. Breadth .11 of an inch.

Remarks.—The teeth are large and angular, with a carina on the outside edge of the angle. The two series are nearly equal in number.

This shell is very similar to the N. concentrica, Say: the points of difference are, however, the greater proportionate length of our species, its carinate umbonial slope, and peculiar teeth. It is also more equilateral, and has the series of teeth more nearly equal. In these two last characters, it also approaches the N. media, Lea.

N. ACUTIDENS, PL. 34. FIG. 29.

N. testâ tenui, lævi, politâ; dentibus magnis, longissimis, arcuatis, acutis, perpendicularibus; cochleâ minimè profundâ.

Shell thin, smooth, polished; teeth large, very long, arcuate, acute, perpendicular; fosset shallow.

Diam. —— Length —— Breadth —— of an inch.

Remarks.—I have but a fragment of the hinge of this shell, but the teeth are so remarkable that they appear to distinguish it from all our other species. They are very long, thin, pointed, and placed perpendicularly to the hinge margin, so as to project beyond the shell and be seen nearly as well externally as internally.

FAMILY MYTILIDÆ.

GENUS MODIOLA.

M. SPINIGERA, PL. 35. FIG. 30.

M. testâ quadrato-ellipticâ, transversâ, inæquilaterali, posticè truncatâ, anticè rotundatâ, sub-inflatâ, tenui, diaphanâ, striatâ; striis parvis, concentricis, irregularibus; clivo umboniali angulato; margine basali recto; margine dorsali recto, spinoso; natibus prominentibus, rotundatis.

Shell quadrately-elliptical, transverse, inequilateral, posteriorly truncate, anteriorly rounded, somewhat inflated, thin, diaphanous, striate; striæ small, concentric, irregular; umbonial slope angulated; basal margin straight; dorsal margin straight, spinous; beaks prominent, rounded.

Diam .08 of an inch. Length .10. Breadth .14.

Remarks.—The spines on the dorsal margin are rather short and few in number; they project perpendicularly from the line of the margin. The substance of the shell is extremely thin. The beaks are long and somewhat incurved.

This little shell is interesting from its singular spinous appendages. No other Modiola, that I have met with, has them. Indeed, the only shell I have ever seen with spines similarly posited, is the Cardium aviculare, Lam., from the Paris Basin.

FAMILY MALLEIDÆ.

GENUS AVICULA.

A. MULTANGULA, PL. 35. FIG. 31.

A. testâ valdè transversâ, sub-inæquilaterali, anticè acutè rostratâ, posticè truncatâ, compressâ, undulatâ, crassâ, striatâ; striis radiantibus minimis, raris; clivo umboniali elevato; margine basali flexuoso; margine dorsali recto; natibus compressis; cardinis areâ triangulari, transversâ; sulco ligamentifero, triangulari, profundo; testæ parte anticâ internè valdè incrassatâ.

Shell very transverse, sub-inæquilateral, acutely rostrate anteriorly, truncate posteriorly, compressed, undulate, thick, striate; striæ few, radiating, very small; umbonial slope elevated; basal margin flexuose; dorsal margin straight; beaks compressed; area of the beaks triangular, transverse; ligamentiferous sulcation triangular, deep; anterior part of the shell, very much incrassated within.

Diam. .18. Length .20. Breadth .45 of an inch.

Remarks.—There are numerous exceedingly minute lines of growth over the surface. The radiating striæ are plainest where they terminate at an angle in the basal margin. The cavity of the beaks is very deep and small. It is abruptly cut off by the incrassation of the anterior end, which is perfectly flat and on a level with the dorsal and basal margins. As all of my specimens are very much worn, I cannot perceive any trace of the muscular impressions.

This curious little shell differs from the genus Avicula somewhat in the hinge. The fosset is more conspicuous than in general with that genus, while the tooth is almost or entirely obsolete. I had at first intended erecting a new genus for it, but the characters of the hinge in this family are so variable and so little to be depended on, that I have thought it best to leave it in this genus. It can hardly be confounded with any of its congeners.

FAMILY PECTENIDÆ.

GENUS PECTEN.

P. MICROPLEURA, PL. 35. FIG. 32.

P. testâ longitudinaliter ovatâ, sub-inflatâ, crassâ, radiatim costatâ; costis parvis, crebris, regularibus, planis, lævibus; margine basali circulari; auribus æqualibus, costatis; natibus compressis, acutis.

Shell longitudinally ovate, somewhat inflated, thick, radiately costate; costæ small, numerous, regular, flat, smooth; basal margin circular; auricles equal, costate; beaks compressed, acute.

Diam. .30. Length .60. Breadth .58 of an inch.

Remarks.—The whole surface, from one auricle to the other, is covered with small, regular, smooth ribs, distant from each other about their own width. They are between thirty and forty in number, besides about ten on each auricle.

This shell may be distinguished from all its congeners of our Tertiary by its small and numerous costæ, and longitudinal form.

P. TENUIS, PL. 35. FIG. 33.

P. testâ sub-orbiculari, æquilaterali, convexâ, tenui, striatâ; striis radiantibus, crebris, tum magnis, tum parvis; lineis concentricis, minutis, raris; natibus acuminatis, sub-elevatis; auribus magnis, inæqualibus, striatis; testâ interne lævi.

Shell sub-orbicular, equilateral, convex, thin, striate; striæ radiating, numerous, sometimes large, sometimes small; a few minute concentric lines; beaks acuminated, somewhat elevated, auricles large, unequal, striate; shell smooth within.

Diam. .60. Length 2.26. Breadth 2.28 inches.

Remarks.—The striæ are very irregular as to size, and frequently are alternate. Near the base they are much smaller; and are decussated by numerous very minute, concentric lines. On the only valve now before me, they are about one hundred in number. The shell has been quite longitudinal when young, as may be seen from the lines of growth. Three or four of the longitudinal striæ are rather larger than the rest, particularly near the beaks.

This pretty shell was found at Shell Bank near Petersburg, the plantation of E. Ruffin, Esq., and sent by him to my father. It may be distinguished from P. Clintonius, Say, a species to which it is closely allied, by its unequal auricles and striæ, its more longitudinal form, and acuminate beaks.

GENUS PLICATULA.

P. RUDIS, PL. 35. FIG. 34.

P. testâ longitudinali, orbiculari, planâ, tenui, rugosâ; natibus prominulis, acutis; dentibus magnis; margine intus lato, nigrescente.

Shell longitudinal, orbicular, flat, thin, rugose; beaks prominent, acute; teeth large, internal margin wide and blackish.

Diam .20. Length .68. Breadth .65 of an inch.

Remarks.—The surface is nearly covered with irregular longitudinal wrinkles, which render it very rugose. It is nearly flat and destitute of folds.

This shell may be distinguished from the P. marginata, Say, which it somewhat resembles, by its flat, orbicular form, rugosities, thinness and want of folds. It is much rarer than that species. I found but three or four specimens of it among more than a hundred of the other.

FAMILY PHYLLIDIDÆ.

GENUS CHITON.

C. TRANSENNA, PL. 35. FIG. 35.

C. testâ—, octovalvi? crassâ, costatâ, dorso valdè elevatâ et angulatâ; valvarum intermediarum areâ centrali costis longitudinalibus rectis, noduliferis, areâ laterali aut lævi aut nodulosâ; valvæ terminalis areâ centrali noduloso costatâ, areâ laterali nodulosâ.

Shell—, eight-valved? thick, costate, very much elevated and angular in the back; central area of the intermediate valves with straight, longitudinal, noduliferous ribs, lateral area smooth or nodulose; central area of the terminal valve nodulosely costate, lateral area nodulose.

Length of valve .15. Breadth do. .50 of an inch.

Remarks.—The ribs of the central area are perfectly parallel, sometimes nearly smooth, and sometimes armed with large nodules in regular series, giving them the appearance of being transversely sulcate. The lateral area, in most of my specimens, is smooth, with the exception of two or three impressed lines of growth, but on some there are numerous spherical tubercles, placed without any apparent order. As these are easily removed, I think it probable that all have been furnished with them, but that, in general, they have been obliterated by attrition. They bear some resemblance to the remains of spines.

This well marked species differs in its sculpture and angulated back from all its congeners.

This shell is interesting as being the first of its genus found in a fossil state in this country. I believe that but one, the C. Grignonensis, Lam., has been described from the Tertiary of Europe.

The third figure is a terminal valve, most probably from a young specimen.

GENUS PATELLA.

P. ACINACES, PL. 35. FIG. 36.

P. testâ ovatâ, valdè compressâ, falcatâ, depressâ, crassâ, striis concentricis parvis; lineis radiantibus posticè quatuor; aperturâ lineari; apice angulato, recto.

Shell ovate, very much compressed, falcate, depressed, thick, with small concentric striæ, and four radiating lines posteriorly, mouth linear; apex angular, straight.

Height .15. Length .55. Breadth .10 of an inch.

Remarks.—The apex is bent forward a little, and somewhat rounded. Diverging from it posteriorly are four elevated lines, two on each side, which may be traced to the base. The aperture is very narrow, almost acute anteriorly and rounded posteriorly. The substance of the shell is extremely thick, particularly at the apex.

It is not without some hesitation that I have classed this little shell with the genus Patella. Its falcate, compressed shape appears hardly to belong to that genus, and yet is not sufficient to found a new one on. If, however, on farther examination, it should prove distinct, I propose the name of Scaphidium* for it, from its peculiar canoe-like shape.

FAMILY CALYPTRÆIDÆ.

GENUS CEMORIA (LEACH.)

C. OBLONGA, PL. 35. FIG. 37.

C. testa conicâ, sub-elevatâ, tenui, diaphanâ, costatâ; costis longitudinalibus, noduliferis, alternantibus; apicè producto, incurvo, anfractu uno, sinistrorsum deflecto, lævi; foramine elliptico; aperturâ quadratâ, oblongâ.

* Α Σκαφιδιον, navigiolum.

Shell conical, somewhat elevated, thin, diaphanous, costate; costæ longitudinal, noduliferous, alternate; apex produced, incurved, with one whorl, deflected to the left; foramen elliptical; aperture quadrate, oblong.

Height .04. Length .07. Breadth .05 of an inch.

Remarks.—The nodules on the ribs are placed in regular series, giving the effect of cancellating transverse striæ. The ribs are alternately large and small, which, I believe, is the case with all our fossil species of these shells. The foramen is widely elliptical, approaching to circular, and placed at some distance posterior to the apex. The apex is large, bent to the left, and twisted into rather more than one whorl. The shell is not much elevated.

But two species of this interesting little genus have been hitherto described. One, the C. noachina, Leach, is from the coast of Great Britain, the other, C. princeps, Mighels and Adams, from that of New England. The one now before us is, I believe, the first fossil species. It differs from the others principally in its minute size, the absence of an internal plate, and the circular form of the foramen.

GENUS CALYPTRÆA.

C. Pileolus, Pl. 35. Fig. 38.

C. testâ irregulariter conicâ, crassâ, sulcatâ; sulcis radiantibus, magnis, irregularibus; striis concentricis, parvis; apice lævi, contorto anfractibus duobus; aperturâ sub-rotundâ; cyatho magno, lato, angulato.

Shell irregularly conical, thick, sulcate; sulci radiating, large, irregular; concentric striæ minute, small; apex smooth, twisted into two whorls; aperture sub-rotund; cyathus large, wide, angular.

Diam. .80. Height .40 of an inch.

Remarks.—This species varies very much both in outline and height, some specimens being nearly flat, while in others the perpendicular distance from the apex to the base is nearly as great as the diameter. The cyathus is large, bent at a right angle, and fastened to the sides of the shell by the two edges. The sulci vary very much in different specimens, both as to number and size.

In general outline, this shell is not unlike the Dispotæa costata, Say, but the form of the cyathus separates it from the Dispotææ, and it also differs in proportionate height. Young specimens are not unlike, in external appearance, the Infundibulum concentricum, herein described, as nearly the upper half of the shell is smooth.

The peculiar voluted form of the apex, which may also be observed in the Dispotæa costata, Say, and D. ramosa, Con., would almost seem to entitle them to a separate division, were it not that in this family the form of the shells is by no means a criterion for that of the animal, and therefore, until the latter has been examined, no separations should be made. M. Lesson and Mr. Owen, who have dissected the inhabitants of these shells, both say that the difference between the animal of Calyptræa and Crepidula is by no means sufficient to establish a generic distinction. Mr. Owen, in a paper read before the Zoological Society, observes, "The soft parts of Crepidula are the same with those of Calyptræa, in all essential points of structure, differing only in the proportionate extent of the anterior part of the foot, and dorsal groove of the mantle." M. Lesson,* as quoted

* Zoologie de la Coquille, Tom. II. p. 388.

by Mr. Broderip, says, "L'animal des Calyptrées et des Crèpidules nous parait ne differer en rien d'essentiel; et quant à la cloison du test, soit que cette cloison soit transversale, soit qu 'elle ne consiste qu 'en lamelles anexées au fond de la coquille, elle presente des passages de ces deux étâts, et ne peut servir qu 'à etablir des simples sous-genres, au grand genre Calyptræa ou Crepidula comme on voudrait l'appeler." I have therefore put the following shells as merely in sub-genera.

SUB-GENUS INFUNDIBULUM (De Montfort.)

I. concentricum, Pl. 35. Fig. 39.

I. testâ patelliformi, depresso-conicâ, tenui, simplici; lineis minutis concentricis; apice centrali, anfractu parvo uno; aperturâ sub-rotundâ; cyatho recto, varice marginato.

Shell patelliform, depressed-conical, thin, simple; with minute concentric lines; apex central, with one small whorl; aperture sub-rotund; cyathus straight, margined with a varix.

Diam. .22. Height .09 of an inch.

Remarks.—This shell is entirely simple and patelliform, with the exception of one small whorl at the apex. The cyathus is flat and straight, extending from the centre to the margin, with a thick varix at its outer edge.

The only Infundibulum, to which this is allied, is the I. centrale, Con., but that species is described as ovate, while this is conical, or even slightly concave.

This is one of the shells that show the gradual passage from the Infundibulum to the Crepidula, and the propriety of uniting these genera. Its want of whorls, and the concentric lines of growth, seem to place it in the Calyptrææ, while the cyathus constitutes it an Infundibulum.

SUB-GENUS CREPIDULA.

C. ponderosa, Pl. 35. Fig. 40.

C. testâ sub-globosâ, crassissimâ, ponderosâ, convolutâ, rugosâ; sulco prope suturam lato, minimè profundo; suturâ parvâ; apice voluto, rotundato, anfractibus sesqui; aperturâ arctato ellipticâ; cyatho crassissimo, undulato, acie flexuosâ, vix aperturæ dimidiam æquante.

Shell sub-globose, very thick, ponderous, whorled, rugose; with a wide, shallow sulcation near the suture; suture small; apex voluted, rounded, with a whorl and a half; mouth narrow-elliptical; cyathus very thick, undulate, with a flexuose edge; scarcely half the length of the mouth.

Height 1.15. Length 1.90. Breadth 1.50 inches.

Remarks.—There are occasional irregular lines of growth over the surface. The sulcation near the suture is sometimes scarcely perceptible. It usually continues for about one third of a whorl from the aperture, and then becomes obsolete. The mouth is sometimes very small and nearly round. The cyathus is extremely solid with two depressions on its surface and a waved edge. It is deeply set in the shell, and disappears gradually into the sides, so that its margin cannot be traced. The apex is more voluted than in any species of Crepidula that I have met with.

This fine shell has, most probably, been heretofore confounded with the C. costata, Morton, as it is too common and too conspicuous to have escaped observation, and as there are specimens of both under that name in the collection of the Academy of Natural

Sciences; but our shell is much larger, more ponderous, with the apex more twisted, and without the spines of the C. costata. I have a number of specimens of each now before me, and I find that these characters obtain at all ages.

C. CORNUCOPIÆ, PL. 35. FIG. 41.

C. testâ valdè elevatâ et convexâ, lævi, politâ, crassâ; apice terminali, valdè producto, voluto, supernè sub-angulato, sinistrorsum deflexo; aperturâ parvâ, ovatâ; cyatho profundo, plano, acie curvo.

Shell much elevated, very convex, smooth, polished, thick; apex terminal, very much produced, whorled, somewhat angular above, turned to the left; aperture small, ovate; cyathus deep, flat, with the margin curved.

Height .16. Length .30. Breadth .18 of an inch.

Remarks.—The apex is very far removed from the margin of the mouth; it is slightly turned to the left, and has about half a volution. The aperture is ovate, approaching to elliptical. The cyathus is situated deep in the shell, so that there is a large cavity under the apex. It is perfectly flat, and its outer margin has a gentle and regular incised curve.

I at first considered this curious little shell as identical with the C. convexa, Say, but the differences in the apex and cyathus render the separation necessary.

C. LAMINA, PL. 35. FIG. 42.

C. testâ, discoidale, planissimâ, tenui, lævi; apice elevato, polito, sinistrorsum deflexo, anfractibus sesqui; aperturâ magnâ, subrotundâ; cyatho parvo, tenui, convexo.

Shell discoidal, very flat, thin, smooth; apex elevated, polished, deflected to the left, with a whorl and a half; aperture large, subrotund; cyathus small, thin, convex.

Height .03. Length .18. Breadth .15 of an inch.

Remarks.—The most peculiar character in the species now before us, is in the shape of the apex. This is perfectly smooth and polished, rising suddenly from the flat back of the shell, and twisted into about a whorl and a half. The margin of the mouth projects anteriorly beyond it, so that it is invisible on a front view. There are small concentric lines of growth over the surface of the shell. The cyathus is slightly and regularly convex.

When very young, this species, from the peculiar formation of the apex, has a striking resemblance to a small Natica, and I have been for some time in doubt as to what genus a specimen of that age belonged.

This shell is closely allied to the C. plana, Say, but the peculiar apex and nearly flat cyathus at once distinguish it.

FAMILY BULLÆIDÆ.

GENUS BULLA.

B. CYLINDRUS, PL. 35. FIG. 43.

B. testâ sub-elliptică, supernè et infernè acuminatâ, crassâ, politâ, striatâ; spirâ umbilicatâ; anfractu ultimo ad basim et apicem striato; aperturâ falcatâ, infernè latâ; columellâ reflectâ.

Shell subelliptical, acuminate above and below, thick, polished, striate; spire umbilicate; last whorl striate at the base and apex; mouth falcate, wide below; columella reflected.

Length .21. Breadth .10 of an inch.

Remarks.—Although this shell has no very peculiar characters, yet I cannot refer it to any described species. One or two species, the B. St. Hillairii and Dekayi, from Claiborne, are somewhat allied to it, but they are not identical.

FAMILY MELANIDÆ.

GENUS PASITHEA, (Lea.)

P. EXARATA, Pl. 35. Fig. 44.

P. testâ subulatâ, acuminatâ, crassâ, imperforatâ, nitente, costatâ; spirâ valdè attenuatâ, mamillatâ, ad apicem lævi; suturis profundis, excavatis; anfractibus quindecim, planulatis, costis obliquè longitudinalibus crebris planis; anfractu ultimo angulato; basi lævi, politâ; aperturâ parvâ, sub-quadratâ, sub-effusâ.

Shell subulate, acuminate, thick, imperforate, shining, costate; spire very attenuate, mamillate, smooth at the apex, sutures deep, excavated; whorls fifteen, flattened, with numerous flat obliquely longitudinal ribs; last whorl angulate; base smooth, polished; mouth small, sub-quadrate, somewhat effuse.

Length .35. Breadth .07 of an inch.

Remarks.—The ribs are slightly oblique. They disappear at both sutures, which are triangular, smooth and deep. They extend, on the last whorl no farther than the angle, leaving the base perfectly smooth. The mouth is ovately quadrate, with sharp angles where the columella and outer lip join the preceding whorls.

This shell appears to resemble the Turritella laqueata, Con., but its larger size, mamilate apex, and angular mouth serve to distinguish it from that species.

P. SUBULA, Pl. 35. Fig. 45.

P. testâ subulatâ, crassâ, imperforatâ, costatâ, striatâ; spirâ attenuatâ, obtusâ, mamillatâ, ad apicem politâ; suturis profundis; anfractibus octo, convexis; costis longitudinalibus magnis, crebris, propè basim obsoletis, planulatis, lævibus; striis transversis, parvis, crebris, interruptis; ultimo anfractu rotundato; basi lævi; aperturâ arctatâ, ellipticâ, subeffusâ.

Shell subulate, thick, imperforate, costate, striate; spire attenuate, obtuse, mamillate, polished at the apex; sutures deep; whorls eight, convex; costæ longitudinal, large, numerous, obsolete near the base, flattened, smooth; striæ transverse, small, numerous, interrupted; last whorl rounded; base smooth; mouth narrow, elliptical, sub-effuse.

Length .18. Breadth .05 of an inch.

Remarks.—The costæ continue almost to the base, when they disappear suddenly, leaving a small place smooth immediately behind the columella. The first whorl of the spire is round, somewhat twisted, smooth and polished, forming a remarkable mamelon. The transverse striæ are very small and do not cross the costæ. The mouth is slightly angular above, and somewhat effuse at base.

This shell attains a greater size than that given above. I have several fragments of much larger specimens.

P. EBURNEA, Pl. 35. Fig. 46.

P. testâ subulatâ, elongatâ, tenui, politâ, sub-perforatâ, costatâ, striatâ; spirâ attenuatâ, mamillatâ, conicâ; suturis linearibus, impressis; anfractibus duodecim, sub-convexis; costis longitudinalibus, magnis, planis, lævibus; prope suturam superiorem striis transversalibus parvis, crebris; prope suturam inferiorem striis transversalibus magnis, raris; anfractu ultimo rotundato; basi striatâ; perforationè pene obsoletâ; aperturâ ovatâ.

Shell subulate, elongated, thin, polished, sub-perforate, costate, striate; spire attenuate, mamillate, conical; sutures linear, impressed; whorls twelve, slightly convex; ribs longitudinal, large, flat, smooth; striæ transverse, near the upper suture small and numerous, near the lower suture large and unfrequent; last whorl rounded; base striate; perforation almost obsolete; mouth ovate.

Length .41. Breadth .10 of an inch.

Remarks.—The transverse striæ do not cross the ribs, which are perfectly smooth and polished. The whorls are divided about the middle by a deep impressed line. Above it is a series of close, small striæ; below it the striæ are larger and more distant. On the body whorl they end at a rather deeper line about the middle. Here also the ribs end, and there is a smooth space before the striæ of the base commence. These are rather large and not numerous. The mouth is acutely angular above and rounded below. The outer lip is sharp.

This elegant little shell is remarkable for its ivory-like appearance. The peculiar arrangement of its transverse striæ distinguishes it from all other species.

P. LÆVIGATA, PL. 35. FIG. 47.

P. testâ elevato-conicâ, acuminatâ, imperforatâ, crassâ, lævi, eburneâ, nitente; spirâ attenuatâ, conicâ, acutâ; suturis linearibus, minimis; anfractibus ——, planis; anfractu ultimo sub-angulato; basi lævi; aperturâ obliquè quadrilaterali, supernè et infernè acutè angulatâ, effusâ.

Shell elevated-conical, acuminate, imperforate, thick, smooth, ivory-like, shining; spire attenuate, conical, acute; sutures linear, very small, whorls —— flat; last whorl somewhat angular; base smooth; aperture obliquely quadrilateral, acutely angular above and below; effuse.

Length .08. Breadth .10 of an inch.

Remarks.—The whorls are perfectly flat, so that the outlines of the spire are straight. The surface of the shell is remarkably smooth and shining.

In my largest specimen the lower whorls have been broken off, so that I am unable to give their number. This fragment, however, has about eleven.

This shell bears some resemblance to the P. aciculata, Lea, from Claiborne, but it may readily be distinguished by its larger size, less attenuate shape, and flatter whorls.

P. OVULUM, PL. 35. FIG. 48.

P. testâ ovatâ, sub-elongatâ, tenui, imperforatâ, lævi, nitente; spirâ breviusculâ, ovatâ, obtusâ; suturis profundis, linearibus; anfractibus quatuor, convexis; anfractu ultimo rotundato; basi lævi; aperturâ ovatâ; columellâ crassâ, latâ; lævi.

Shell ovate, somewhat elongate, thin, imperforate, smooth, shining; spire rather short, ovate, obtuse; sutures deep, linear; whorls four, convex; last whorl rounded; base smooth; mouth ovate; columella thick, wide, smooth.

Length .15. Breadth .08 of an inch.

Remarks.—The mouth is angular above and rounded below. The sutures are deep, owing to a slight conical depression of the whorls immediately at their junction with those above.

I know no species to which the above is allied.

P. DIAPHANA, PL. 35. FIG. 49.

P. testâ ovato-elongatâ, acuminatâ, tenui, sub-perforatâ, diaphanâ, striatâ; spirâ subattenuatâ, mamillatâ; suturis impressis, linearibus; anfractibus sex, convexis; striis minutis, transversalibus; anfractu ultimo rotundato; basi striatâ; aperturâ elongato-quadratâ, sub-effusâ.

Shell ovately elongate, acuminate, thin, sub-perforate, diaphanous, striate; spire somewhat attenuate, mamillate; sutures impressed, linear; whorls six, convex; striæ transverse, minute; last whorl rounded; base striate; mouth elongately-quadrate, sub-effuse.

Length .22. Breadth .10 of an inch.

Remarks.—The striæ are very small and only to be seen with the aid of a microscope. The shell is very thin,—so much so as to be somewhat translucent. The mouth is angular above and below. There is a slight angle on the superior part of the whorls, immediately below the upper suture.

This pretty little shell has no decided resemblance to any of our fossil species. P. sulcata, Lea, approaches it more nearly than any other.

P. TURBINOPSIS, PL. 35. FIG. 50.

P. testâ ovato-conoideâ, sub-elevatâ, tenui, lævi, imperforatâ; spirâ breviusculâ, rotundatâ, obtusâ; suturis profundis; anfractibus quatuor, convexis, propè suturam superiorem sub-canaliculatis; anfractu ultimo rotundato; basi lævi; aperturâ magnâ, sub-rotundâ.

Shell ovately conoidal, somewhat elevated, thin, smooth, imperforate; spire rather short, rounded, obtuse; sutures deep; whorls four, convex, sub-canaliculate near the upper suture; last whorl rounded; base smooth; mouth large, sub-rotund.

Length .10. Breadth .05 of an inch.

Remarks.—The whorls have a small angle immediately at the upper suture, which gives them somewhat the appearance of being channelled. The mouth is oblique, nearly round, and has the lower margin produced obliquely, below the inner lip.

I have felt some doubts in placing this shell among the Pasitheæ, as it hardly has the effuse mouth of that genus, but its characters seem to agree better with it than with any other.

This little shell resembles some of our recent species of Amnicola;—it also approaches the Turbo minutus, Totten (Cingula minuta, Gould,) but it is more globose and differs in size.

P. ORNATA.

P. testâ ovato-subulatâ, crassâ, sub-perforatâ, costatâ, striatâ; spirâ elevatâ, mamillatâ, prope apicem lævi; suturis linearibus; anfractibus quinque, valdè convexis; costis transversalibus, latis, politis; striis longitudinalibus, minutissimis; anfractu ultimo rotundato; basi costulatâ; perforatione pene obsoletâ; aperturâ ovatâ, effusâ.

Shell ovately subulate, thick, sub-perforate, costate, striate; spire elevated, mamillate, smooth near the apex; sutures linear; whorls five, very convex; costæ transverse, wide, polished; striæ longitudinal, very minute; last whorl rounded; base costulate; perforation almost obsolete; mouth ovate, effuse.

Length —— Breadth ——

Remarks.—On the upper whorls the costæ are five in number, on the last one they are much more numerous. Those on the base are smaller and closer together. Near the lower sutures, on the whorl next the last, is a rib larger than the rest, with an impressed line in its centre, making a kind of double rib. It may be traced round the middle of the last whorl. As I have but one specimen before me, I cannot decide whether this is a general character or not. The longitudinal striæ are only to be seen in the intervals of the ribs. They are very small and sometimes disappear.*

* I unfortunately lost my only specimen of this shell after describing, but before measuring or making a drawing of it. I am, therefore, unable to give either the dimensions or a figure. It was, however, not more than a quarter of an inch in length, at the utmost.

FAMILY NERITIDÆ.

GENUS NATICA.

N. APERTA, PL. 36. FIG. 51.

N. testâ obliquè ellipticâ, tenui, costulatâ, sub-striatâ, perforatâ; spirâ depressâ, ovatâ, obtusâ, propè apicem lævi; suturis parvis, linearibus; anfractibus quatuor, convexis; costulis transversalibus, crebris, planis, quadrangularibus; striis longitudinalibus, minutissimis; anfractu ultimo ovato; basi obliquè costulatâ; perforatione parvâ, angustâ; aperturâ maximâ, supernè sinuatâ, infernè ellipticâ.

Shell obliquely elliptical, thin, costulate, sub-striate, perforate; spire depressed, ovate, obtuse, smooth near the apex; sutures small, linear; whorls four, convex; costulæ numerous, transverse, quadrangular, flat; striæ longitudinal, very small; last whorl ovate; base obliquely costulate; perforation small, narrow; mouth very large, sinuate above, elliptical below.

Length .70. Breadth .62 of an inch.

Remarks.—The costulæ are small, wider than the spaces between them, and very numerous. The longitudinal lines of growth are exceedingly minute; so much so as to be invisible to the naked eye. Both ribs and striæ become obsolete on the upper whorls, so that the two or three nearest the apex are smooth. The mouth is somewhat lunate, contracted above and expanded below. The umbilicus is small, and nearly concealed by the columella.

This shell is closely allied to the N. fragilis, Conrad, and it is with some hesitation that I separate it. It, however, differs in the ribs, the umbilicus, and the shape of the mouth.

N. SPHÆRULUS, PL. 36. FIG. 52.

N. testâ globoso-acuminatâ, obliquâ, tenui, lævi, politâ, imperforatâ; spirâ breviusculâ, sub-conicâ, acutâ; suturis parvis, impressis; anfractibus quatuor, sub-convexis; anfractu ultimo rotundato; basi lævi; umbilico occulto; callo semicirculari, lineâ impressâ marginato; aperturâ semi-ovatâ; columellâ rectâ, supernè incrassatâ.

Shell globosely acuminate, oblique, thin, smooth, polished, imperforate; spire rather short, sub-conical, acute; sutures small, impressed; whorls four, somewhat convex; last whorl rounded; base smooth; umbilicus hidden; callus semicircular, margined by an impressed line; mouth semi-ovate; columella straight, incrassated above.

Length .12. Breadth .11 of an inch.

Remarks.—This shell is too small and perfect to be the young of so large a species as N. duplicata, which it resembles. Out of twenty or thirty specimens the admeasurements given above were the largest, the others decreasing to a size scarcely visible without a microscope. The only other species to which it is allied is the N. percallosa, Conrad, but the small size and more elevated spire distinguish it.

N. CRASSILABRUM, PL. 36. FIG. 53.

N. testâ transversè ellipticâ, depressâ, crassâ, lævi, politâ, imperforatâ; spirâ conicâ, obtusâ, valdè depressâ; suturis profundis, linearibus; anfractibus quatuor, convexis, supernè planulatis; anfractu ultimo rotundato; basi lævi; umbilico occulto, parvo; aperturâ sub-rotundâ; labro supernè valdè incrassato.

Shell transversely elliptical, depressed, thick, smooth, polished, imperforate; spire conical, obtuse, very much depressed; sutures deep, linear; whorls four, convex, flattened above; last whorl rounded; base smooth; umbilicus hidden, small; mouth sub-rotund; outer lip much thickened above.

Length .16. Breadth .25 of an inch.

Remarks.—The flattened whorls and incrassated outer lip at once distinguish this shell from all its congeners.

FAMILY PLICACIDÆ.

GENUS ACTEON.

A. GRANULATUS, PL. 36. FIG. 54.

A. testâ subulatâ, crassâ, sub-perforatâ, noduloso-costatâ; spirâ elevatâ, obtusâ, mamillatâ, ad apicem politâ; suturis impressis; anfractibus sex, convexis; costis transversalibus, planis, regulariter nodulosis, unâ lævi prope suturam inferiorem; anfractu ultimo rotundato; perforatione minimâ; basi costatâ; aperturâ ovatâ, supernè angulatâ, sub-effusâ; plicâ columellari magnâ, acutâ.

Shell subulate, thick, sub-perforate, nodulously costate; spire elevated, obtuse, mamillate, polished at the apex; sutures impressed; whorls six, convex; ribs transverse, flat, regularly nodulous, a smooth one near the lower suture; last whorl rounded; base costate; perforation very small; mouth ovate, angular above, somewhat effuse; fold on the columella large, acute.

Length .18. Breadth .08 of an inch.

Remarks.—The nodules on the ribs are small and in regular order, giving the shell a granulate and cancellated appearance. The fold on the columella is placed about the middle, and is quite large. The mouth is rounded below and acutely angular above. On the body whorl the ribs are about eight in number, while there are five on those of the spire. The basal costæ are smooth and smaller.

Judging from description, this shell is not unlike A. pomilius and A. idoneus, Conrad; but may be distinguished by the perforation, mamillate apex, and the smooth rib near the lower suture.

A. GLOBOSUS, PL. 36. FIG. 55.

A. testâ ovatâ, crassâ, cancellatâ, umbilicatâ; spirâ brevi, ad apicem lævi et politâ; suturis parvis; anfractibus tribus, convexis, rapidè crescentibus, supra planulatis; costis octo, transversis, magnis; striis longitudinalibus, parvis, irregularibus; anfractu ultimo rotundato; basi cancellatâ; umbilico magno; aperturâ magnâ, sub-ellipticâ; columellâ rectâ; plicâ columellari magnâ, acutâ.

Shell ovate, thick, cancellate, umbilicate; spire short, smooth and polished at the apex; sutures small; whorls three, rapidly increasing, convex, flattened above; costæ eight, transverse, large; striæ longitudinal, small, irregular; last whorl rounded; base cancellate; umbilicus large; aperture large, sub-elliptical; columella straight; fold on the columella large, acute.

Length .10. Breadth .08 of an inch.

Remarks.—The longitudinal striæ occasionally do not cross the ribs, which, in that case, are rounded and polished. The mouth is somewhat semicircular, with the columella for a base. On the upper whorls there are but four ribs, the rest being concealed by the succeeding growth. About a whorl and a half near the apex, are perfectly smooth.

This is a very pretty little shell, and bears no decided resemblance to any of our fossil species. It is unusually globose for an Acteon, but can hardly be placed in the kindred genus Tornatella.

A. TURBINATUS, PL. 36. FIG. 56.

A. testâ ovato-conicâ, crassâ, lævi, sub-perforatâ; spirâ breviusculâ, conicâ, obtusâ; suturis parvis, linearibus; anfractibus quinque, planulatis; anfractu ultimo sub-angulato; basi lævi; perforatione minimâ; aperturâ ovatâ, sub-effusâ; plicâ columellari magnâ, acutâ.

Shell ovately conical, thick, smooth, sub-perforate; spire rather short, conical, obtuse; sutures small, linear; whorls five, flattened; last whorl somewhat angular; base smooth; perforation very small; mouth ovate, sub-effuse; fold on the columella large, acute.

Length .12. Breadth .08 of an inch.

Remarks.—The fold on the columella is placed about the middle. It can scarcely be seen on a front view; but when the shell is placed obliquely, it appears very large. The mouth is acutely angular above, and rounded and somewhat effuse below. On one specimen I have observed a small impressed transverse line near the upper suture, but my other ones want it.

This little shell, though without any conspicuous characteristics, does not resemble any of our described species.

A. ANGULATUS, PL. 36. FIG. 57.

A. testâ subulatâ, infernè ovatâ, crassâ, imperforatâ, lævi; spirâ attenuatâ, conicâ, mamillatâ; suturis profundis; anfractibus sex, planulatis, propè suturam inferiorem angulatis; anfractu ultimo angulato; basi lævi; aperturâ parvâ, subellipticâ; plicâ columellari obtusâ, obliquâ.

Shell subulate, ovate below, thick, imperforate, smooth; spire attenuate, conical, mamillate; sutures deep; whorls six, flattened, angulate near the lower suture; last whorl angular; base smooth; mouth small, sub-elliptical; fold on the columella obtuse, oblique.

Length .12. Breadth .05 of an inch.

Remarks.—The mouth is nearly elliptical. The angle on the lower part of the whorls is only visible on the inferior ones. Nearer the apex, it becomes obsolete, or is covered by the succeeding whorls.

This shell is not unlike the A. melanellus, Lea, but differs from that species in the angular whorls, smaller size, and want of an umbilicus.

A. GLANS, PL. 36. FIG. 58.

A. testâ sub-ovatâ, tenui, imperforatâ, lævi, glabrâ; spirâ ovato-conicâ, brevi, mamillatâ; suturis profundis; anfractibus quatuor, minimè convexis, ad suturam superiorem sub-canaliculatis; anfractu ultimo rotundato; basi lævi; aperturâ ovatâ, valdè effusâ; plicâ columellari parvâ, obliquâ.

Shell sub-ovate, thin, imperforate, smooth, glabrous; spire ovately-conical, short, mamillate; sutures deep; whorls four, very slightly convex, sub-canaliculate at the upper suture; last whorl rounded; base smooth; mouth ovate, very effuse; fold on the columella small, oblique.

Length .10. Breadth .05 of an inch.

Remarks.—The mouth is very effuse below; so much so, indeed, that it appears to have the rudiments of a canal. It is acutely angular above. The fold on the columella is obtuse, rising abruptly on the upper part and declining gradually on the lower.

This little shell, from its ovate outline, and the form of its fold, should perhaps be placed in the Tornatella, but the limits of these two genera are so indistinct that it is difficult to decide where the boundary between them exists. I have felt the same doubt with respect to several of the following species, as the A. sculptus, nitens, &c.

A. SCULPTUS, PL. 36. FIG. 59.

A. testâ ovato-acuminatâ, crassâ, sub-perforatâ, cancellatâ; spirâ brevi, conicâ, mamillatâ, ad apicem lævi; suturis profundis; anfractibus quinque, convexis, ad suturam superiorem sub-canaliculatis; striis transversis, crebris, magnis; sulcis longitudinalibus, parvis, propè suturam inferiorem obsoletis; anfractu ultimo rotundato; basi striatâ; perforatione minimâ; aperturâ ovatâ, effusâ; plicâ columellari obliquâ, obtusâ.

Shell ovate-acuminate, thick, sub-perforate, cancellate; spire short, conical, mamillate, smooth at the apex; sutures deep; whorls five, convex, sub-canaliculate near the upper sutures; striæ transverse, numeroùs, large; sulci longitudinal, small, nearly obsolete at the lower suture; last whorl rounded; base striate; perforation very small; mouth ovate, effuse; fold on the columella oblique, obtuse.

Length .11. Breadth .05 of an inch.

Remarks.—The transverse striæ are extremely numerous. Near the base they become alternate. The longitudinal sulcations are small; they are very perceptible near the superior suture, but gradually become obsolete as they approach the lower part of the whorls. The perforation is extremely minute,—so much so as to be almost obsolete. The margin of the mouth is continuous round the inner lip. This character is wanting in young and unfinished specimens. The fold on the columella can scarcely be seen on a front view. The upper side of it is perpendicular, the lower very oblique.

This shell and the last are almost too bullate to be classed with the Acteons. They may, perhaps, more properly belong to the Tornatellæ.

A. NITENS, PL. 36. FIG. 60.

A. testâ ovato-acuminatâ, crassâ, perforatâ, lævi, politâ; spirâ subulatâ, mamillatâ; suturis impressis, profundis; anfractibus quinque, convexis; anfractu ultimo rotundato; basi lævi; perforatione parvâ; aperturâ ovatâ, elongatâ, effusâ; plicâ columellari obtusâ, crassâ.

Shell ovate-acuminate, thick, perforate, smooth, polished; spire subulate, mamillate; sutures impressed, deep; whorls five, convex; last whorl rounded; base smooth; perforation small; mouth ovate, elongated, effuse; fold on the columella obtuse, thick.

Length .18. Breadth .10 of an inch.

Remarks.—The mouth is large, acute above and rounded and effuse below. The last whorl expands rather suddenly beyond the line of the rest, and is more than half the length of the shell. The fold on the columella is broad at base, but slightly elevated, and obtuse. The surface of the shell is remarkably glabrous and shining.

The external outline has more the aspect of a Phasianella than that of an Acteon. I know none of its congeners to which it is allied.

A. MILIUM, PL. 36. FIG. 61.

A. testâ ovato-conicâ, crassâ, perforatâ, striatâ, politâ; spirâ sub-attenuatâ, conicâ, obtusâ, ad apicem lævi; suturis linearibus, impressis; anfractibus quinque, planulatis; striis transversalibus, raris, impressis; anfractu ultimo rotundato; basi crebrè striatâ; perforatione parvâ; aperturâ ovatâ, integrâ; plicâ columellari magnâ, acutâ, ad basim latâ.

Shell ovately conical, thick, perforate, striate, polished; spire somewhat attenuate, conical, obtuse, smooth at the apex; sutures linear, impressed; whorls five, flattened; striæ transverse, few, impressed; last whorl rounded; base closely striate; perforation small; mouth ovate, entire; fold on the columella large, acute, wide at base.

Length .10. Breadth .04 of an inch.

Remarks.—On the upper whorls the striæ are three in number. On the last whorl they are much more numerous, particularly towards the base, where they become

smaller and closer. The mouth is not effuse, acutely angular above and rounded below. The fold on the columella is unusually large, and is very wide at base.

The only species of Acteon, with which this little shell could be confounded, is the A. melanoides, Conrad, but its smaller size, more ovate shape, and greater number of striæ on the body whorl, sufficiently distinguish it from that species.

A. SIMPLEX, PL. 36. FIG. 62.

A. testâ elevato-conicâ, acuminatâ, crassâ, lævi, perforatâ; spirâ attenuatâ, mamillatâ; suturis excavatis, profundis; anfractibus sex, planis, ad suturam inferiorem angulatis; anfractu ultimo angulato; basi lævi; perforatione parvâ; aperturâ quadratâ, effusâ; plicâ columellari lamellari, acutâ.

Shell elevately conical, acuminate, thick, smooth, perforate; spire attenuate, mamillate; sutures excavated, deep; whorls six, flat, angulated at the lower suture; last whorl angular; base smooth; perforation small; mouth quadrate, effuse; fold on the columella lamellar, acute.

Length .12. Breadth .05 of an inch.

Remarks.—The mamelon of the apex is large and very irregular in its shape. The angle on the whorls is very near the lower suture, which gives them somewhat the appearance of being canaliculate. The fold on the columella is acute and very thin. The mouth is angular above and below.

This shell bears a general resemblance to some of the smooth Acteons from Claiborne, without being sufficiently allied to enable me to class it with any of them. It also closely approaches the A. angulatus, herein described, but the umbilicus of this species readily distinguishes it.

GENUS PYRAMIDELLA.

P. SUTURALIS, PL. 36. FIG. 63.

P. testâ turritâ, elevatâ, crassâ, lævi, nitente, perforatâ, sulcatâ; spirâ conicâ, attenuatâ; suturis linearibus; anfractibus octo, planis; anfractu ultimo angulato, medio sulcato; sulco uno, parvo, transverso; basi carinatâ; perforatione minimâ; aperturâ quadratâ, valdè effusâ; columellâ triplicatâ, plicâ unâ maximâ acutâ, duobus parvis; labro dentibus magnis internis, aut duobus aut tribus.

Shell turrited, elevated, thick, smooth, shining, perforated, sulcate; spire conical, attenuate; sutures linear; whorls eight, flat; last whorl angular, sulcate in the middle; sulcus transverse, small; base carinate; perforation very small; mouth quadrate, very effuse; columella with three folds, one very large and acute, the others small; outer lip with two or three large teeth internally.

Length .20. Breadth .08 of an inch.

Remarks.—The sulcation on the last whorl is seen at the upper part of those of the spire, forming an apparently double suture. This sulcation is triangular, with one side perpendicular and the other very sloping. Immediately above it is a little raised ridge, or small carina. The sulcation is placed directly on the angle of the last whorl. Of the folds on the columella, the upper one is large and horizontal, situated immediately at its junction with the preceding whorl. The two lower ones are smaller and oblique. The teeth on the outer lip are generally two, placed close together near the middle, but there is sometimes a third, smaller one, below them. The carina on the base is broad and little elevated, immediately surrounding the umbilicus. The mouth is acutely angular above and below. This shell attains a greater size than that mentioned above, as I have an imperfect specimen larger than the one whose dimensions and figure are given.

Judging from description, this shell is not unlike the P. larvata, Con., from Claiborne, but that species is not mentioned as having three folds on the columella, or the teeth on the outer lip.

P. ELABORATA, PL. 36. FIG. 64.

P. testâ elevato-conicâ, crassâ, imperforatâ, costatâ, striatâ; spirâ minimè ovatâ, mamillatâ; suturis linearibus, impressis; anfractibus sex, convexis; costis longitudinalibus, crebris, planis, lævibus, politis; striis transversis, parvis; anfractu ultimo rotundato; aperturâ elliptică; columellâ plicis tribus magnis.

Shell elevately conical, thick, imperforate, costate, striate; spire slightly ovate, mamillate; sutures linear, impressed; whorls six, convex; costæ longitudinal, numerous, flat, smooth, polished; striæ transverse, small; last whorl rounded; mouth elliptical; columella with three large folds.

Length .15. Breadth .08 of an inch.

Remarks.—The transverse striæ are very small and do not cross the ribs. The folds on the columella are of nearly equal size, but the upper one is rather larger than the others.

As the only two specimens of this shell in my possession have had the lower whorl broken off, I am unable to give the full size or number of whorls, as well as to determine whether there are teeth on the outer lip or not.

I have never seen a Pyramidella with a sculpture as elaborate as this. The genus mostly contains plain species.

FAMILY SCALARIDÆ.

GENUS SCALARIA.

S. ACICULA, PL. 36. FIG. 65.

S. testâ turritâ, crassâ, imperforatâ, costatâ; spirâ attenuatâ, ad apicem vix lævi; suturis profundis; anfractibus septem, valdè convexis; costis longitudinalibus, lamellaribus, acutis, ad basim decrescentibus; anfractu ultimo rotundato; basi carinâ minimâ transversâ; aperturâ rotundâ.

Shell turrited, thick, imperforate, costate, spire attenuate, nearly smooth at the apex; sutures deep; whorls seven, very convex; costæ longitudinal, lamellar, acute, decreasing at the base; last whorl rounded; base with a very small transverse carina; mouth round.

Length .20. Breadth .10 of an inch.

Remarks.—The carina on the base is small and does not interfere with the ribs, which continue to the columella. The whorls are perfectly smooth with the exception of the ribs, which, on the body whorl are fifteen in number.

S. CORNIGERA, PL. 36. FIG. 66.

S. testâ elevato-conicâ, scalariformi, imperforatâ, crassiusculâ, costatâ; spirâ attenuatâ, obtusâ, conicâ; suturis valdè impressis; anfractibus sex, convexis, supernè valdè angulatis; costis sub-tenuibus, planis, supernè valdè productis et acutè angulatis; basi lævi; aperturâ rotundatâ, minimè effusâ.

Shell elevately conical, scalariform, imperforate, rather thick, costate; spire attenuate, obtuse, conical; sutures very much impressed; whorls six, convex, very angular above; costæ rather thin, flat, very much produced and acutely angled above; base smooth; mouth round, slightly effuse.

Length .16. Breadth .08 of an inch.

Remarks.—On the upper part of the spire the angle of the whorls is near their middle. Below, it is close to the superior suture. The ribs rise, near the upper part of the whorls, to a short spine, and descend rapidly to the suture, where they become obsolete. The mouth is small and nearly round.

This little shell I at first thought to be merely the young of S. pachypleura, Conrad; but, as it is but one fifth the size of that species, with the same number of whorls, they cannot be identical.

S. MICROPLEURA, PL. 36. FIG. 67.

S. testâ elevato-pyramidali, tenui, imperforatâ, costulatâ; spirâ attenuatâ, conicâ, obtusâ; suturis parvis, linearibus; anfractibus sex, convexis; costis minutis, crebrissimis; anfractu ultimo rotundato; basi lævi; aperturâ ovatâ, marginibus supernè disjunctis; labro acuto.

Shell elevately pyramidal, thin, imperforate, costulate; spire attenuate, conical, obtuse; sutures small, linear; whorls six, convex; ribs very small and numerous; last whorl rounded; mouth ovate, with the margins disunited above; outer lip acute.

Length .10. Breadth .05 of an inch.

Remarks.—I have felt some hesitation in placing this shell among the Scalariæ, as the small costæ and incontinous peritreme of the mouth seem scarcely to warrant it.

S. MICROSTOMA, PL. 36. FIG. 68.

S. testâ subulato-conicâ, tenui, imperforatâ, costatâ; spirâ conicâ, valdè attenuatâ, obtusâ; suturis impressis, interruptis; anfractibus septem, valdè convexis; costis raris, elevatis, reflexis; anfractu ultimo rotundato; basi sub-carinatâ; aperturâ parvâ, obliquâ, sub-rotundâ; labro valdè incrassato.

Shell subulate-conical, thin, imperforate, costate; spire conical, very attenuate, obtuse; sutures impressed, interrupted; whorls seven, very convex; costæ few, elevated, reflexed; last whorl rounded; base sub-carinate; mouth small, oblique, sub-rotund; outer lip very much thickened.

Length .28. Breadth .12 of an inch.

Remarks.—The carina of the base is very small; it does not cross the costæ, which continue to the columella. The mouth is unusually small and nearly round. The costæ are ten in number on the last whorl, quite prominent, and reflexed. In full grown specimens the one which forms the outer lip is much thicker than the rest. The ribs of one whorl do not join those of the next, but lap over very closely. This causes the sutures to be continually interrupted.

This shell bears a close resemblance to S. acicula, herein described, but differs in being more subulate, having fewer and reflected ribs, and a smaller basal carina.

GENUS DELPHINULA.

D. COSTULATA, PL. 36. FIG. 69.

D. testâ orbiculari, depressâ, crassâ, costatâ, striatâ; spirâ brevissimâ, acuminatâ, acutâ; suturis linearibus; anfractibus sex, valdè convexis, suprâ planulatis et lævibus; costis parvis, crebris, transversis, politis; striis longitudinalibus, obliquis, minutissimis; anfractu ultimo rotundato; basi costatâ; umbilico magno, profundo, intus lævi; aperturâ rotundâ, supra sub-canaliculatâ.

Shell orbicular, depressed, thick, costate, striate; spire very short, acuminate, acute; sutures linear; whorls six, very convex, smooth and flattened above; costæ transverse, small, numerous, polished; striæ longitudinal, oblique, very minute; last whorl rounded; base costate, umbilicus large, deep, smooth within, mouth round, sub-canaliculate above.

Length .08. Breadth .15 of an inch.

Remarks.—The longitudinal striæ are so minute as to escape observation, unless assisted by a powerful microscope. They do not cross the ribs. The mouth is smooth within, and almost exactly round, except at its junction with the preceding whorl, where there is a small channel.

This shell bears some resemblance to the Turbo lineatus, Lea, but is separated from that shell by its entire mouth, larger umbilicus, &c.

I have felt some doubt in placing this and two or three of the following shells in the genus Delphinula. Their general appearance would seem rather to make them approach the Turbo, but their entire mouths constitute them true Delphinulæ. The genus Skenea, Fleming, seems well fitted to receive them, but it is described as having the "aperture dilated," a character which is wanting in the shells at present under consideration.

D. CONCAVA, PL. 36. FIG. 70.

D. testâ concavâ, orbiculari, depressâ, supra planulatâ, tenui, nitente, sub-striatâ; spirâ brevissimâ, obtusâ; suturis linearibus; anfractibus quatuor, rapidè crescentibus, planulatis; striis longitudinalibus, parvis, rarissimis; anfractu ultimo sub-angulato; basi striatâ; umbilico magno, profundo, intus striato; aperturâ magnâ, ovatâ.

Shell concave, orbicular, depressed, flattened above, thin, shining, sub-striate; spire very short, obtuse; sutures linear; whorls four, rapidly increasing, flattened; striæ longitudinal, very few, small; last whorl somewhat angular; base striate; umbilicus large, deep, striate within; mouth large, ovate.

Length .08. Breadth .20 of an inch.

Remarks.—The umbilicus is wide and open, exposing the spire, nearly to the apex. The lines of growth are very infrequent and irregular, both as to size and direction.

This little shell has no very decided character, and yet it cannot be placed with any species hitherto described. Its nearest analogue is the recent Planorbis parvus, Say, which it much resembles in general outline.

D. LIPARA, PL. 36. FIG. 71.

D. testâ orbiculari, depressâ, sub-planulatâ, crassiusculâ, lævi, nitente; spirâ brevissimâ, rotundatâ; suturis impressis; anfractibus quinque, convexis, politis; anfractu ultimo rotundato; basi lævi; umbilico latissimo, profundo; aperturâ rotundâ.

Shell orbicular, depressed, somewhat flattened, rather thick, smooth, shining; spire very short, rounded; sutures impressed; whorls five, convex, polished; last whorl rounded; base smooth; umbilicus very wide, deep; mouth round.

Length .05. Breadth .10 of an inch.

Remarks.—In this shell the umbilicus is wider than in most of those herein described. The mouth is small and very nearly round. The surface has a very high polish, and a somewhat greasy look.

This species is very much like the Skenea depressa, a recent shell from the coast of England, but it is much larger, and differs in the shape of the aperture.

D. OBLIQUÈ-STRIATA, PL. 36. FIG. 72.

D. testâ orbiculari, depressâ, crassâ, diaphanâ, sub-cancellatâ; spirâ brevissimâ, ovatâ, propè apicem longitudinaliter et profundè sulcatâ; suturis impressis, linearibus; anfractibus quatuor, convexis; sulculis longitudinalibus, ad suturam inferiorem pene obsoletis; striis obliquè transversis, parvis, crebris; anfractu ultimo tum carinato tum angu-

lato, ad suturam lævi; basi striatâ, profundè sulcatâ; umbilico magno, profundo, carinâ marginato, intus lævi; aperturâ rotundâ.

Shell orbicular, depressed, thick, diaphanous, sub-cancellate; spire very short, ovate, longitudinally and deeply sulcate near the apex; sutures impressed, linear; whorls four, convex; sulculi longitudinal, nearly obsolete at the lower suture; striæ obliquely transverse, small, numerous; last whorl sometimes carinate, sometimes angulate, smooth near the suture; base striate, deeply sulcate; umbilicus large, deep, margined with a carina, smooth within; mouth round.

Length .04. Breadth .10 of an inch.

Remarks.—The longitudinal sulci are quite large on the upper whorls, but become smaller and closer as they approach the last whorl, while on the base they again increase. The striæ are very oblique, but are more nearly transverse than longitudinal. On the last whorl, they form cancellations with the sulci, and are obsolete near the suture as they approach the mouth. The umbilicus is carinate and scalariform, decreasing from whorl to whorl in rectangular steps. The periphery of the last whorl is extremely variable, being in some specimens almost round, and in others angular and carinate. The mouth is almost a perfect circle.

The carinate umbilicus and oblique striæ separate this pretty little shell from all its congeners.

D. TROCHIFORMIS, PL. 36. FIG. 73.

D. testâ conicâ, sub-lenticulari, crassâ, striatâ; spirâ sub-ovatâ, obtusâ, depressâ; suturis canaliculatis; anfractibus tribus, sub-convexis; striis transversis, parvis, raris; anfractu ultimo acutè angulato, duplicè carinato; basi striatâ; umbilico parvo, profundo, striis magnis marginato; aperturâ sub-triangulari; labro crassissimo.

Shell conical, somewhat lenticular, thick, striate; spire sub-ovate, obtuse, depressed; sutures canaliculate; whorls three, rather convex; striæ transverse, few, small; last whorl acutely angular, doubly carinate; base striate; umbilicus small, profound, margined with large striæ; mouth sub-triangular; lip very thick.

Length .08. Breadth .09 of an inch.

Remarks.—The striæ on the upper part of the last whorl are few in number and very faint; on the base, however, they are more numerous and deeper. There are usually two or three of larger size round the umbilicus. The periphery of the last whorl has two carinæ, one upon the angle, and one immediately above it. On the superior whorls these are both hidden.

This shell, in outline, seems rather to be a Trochus than a Delphinula. Its spire is very much elevated, and its umbilicus unusually small for this genus, but the entire margin of the mouth is a character too well marked to be neglected.

D. GLOBULUS, PL. 36. FIG. 74.

D. testâ transversè sub-globosâ, crassâ, cancellatâ; spirâ planulatâ, obtusâ, ad apicem lævi; suturis vix obsolètis; anfractibus tribus, rapidè crescentibus, supra angulatis et planulatis; costis transversis, octo, magnis; striis longitudinalibus, parvis, irregulâribus; anfractu ultimo rotundata; basi costatâ et striatâ; umbilico parvo, arctato; aperturâ sub-rotundâ, integrâ.

Shell transversely sub-globose, thick, cancellate; spire flattened, obtuse, smooth at the apex; sutures nearly obsolete; whorls three, rapidly increasing, angular and flattened above; costæ transverse, eight, large; striæ longitudinal, small, irregular; last whorl rounded; base costate and striate; umbilicus small, narrow; mouth sub-rotund, entire.

Length .15. Breadth .18 of an inch.

Remarks.—The longitudinal striæ, or lines of growth very frequently do not cross the ribs. The mouth is slightly quadrate. The sculpture is not unlike that of the Acteon globosa, herein described.

This shell may be identical with the D. lyra, Conrad, but its ribs are entire and its aperture is not dilated. It is also much smaller.

D. APERTA, PL. 36. FIG. 75.

D. testâ rotundato-conicâ, sub-elevatâ, tenui, sulcatâ; spirâ brevi, obtusâ; suturis linearibus; anfractibus tribus, convexis, rapidè crescentibus; sulcis longitudinalibus, minutis, irregularibus, penè obsoletis; anfractu ultimo sub-angulato; basi sub-sulcatâ, umbilico magno, lato, profundo; aperturâ ovato triangulari, integrâ.

Shell rounded-conical, somewhat elevated, thin, sulcate; spire short, obtuse; sutures linear; whorls three, convex, rapidly increasing; sulci longitudinal, minute, irregular, almost obsolete; last whorl sub-angular; base slightly sulcate; umbilicus large, wide, profound; mouth ovately triangular, entire.

Length .05. Breadth .08 of an inch.

Remarks.—The longitudinal sulci are very variable. The apex is almost mamillate. The whorls are very much separated from each other by their convexity and the size of the umbilicus.

This is the most elevated species of the genus that I have met with.

D. NATICOIDES, PL. 36. FIG. 76.

D. testâ discoideâ, crassissimâ, lævi; spirâ planulatâ; suturis linearibus; anfractibus tribus, convexis; anfractu ultimo maximo, rotundato; basi lævi; umbilico parvo, minimè profundo; aperturâ parvâ, ovatâ; labro supernè valdè incrassatâ.

Shell discoidal, very thick, smooth; spire flattened; sutures linear; whorls three, convex; last whorl very large, rounded; base smooth; umbilicus small, shallow; mouth small, ovate; outer lip very much thickened above.

Length .07. Breadth .12 of an inch.

Remarks.—The last whorl almost covers those of the spire. The surface seems somewhat roughened. The mouth is nearly round.

In general outline, this shell bears a strong resemblance to some species of Natica. In this it differs from all the Delphinulæ I have met with.

FAMILY TURBINIDÆ.

GENUS ROTELLA.

R. SUB-CONICA, PL. 36. FIG. 77.

R. testâ orbiculari, sub-depressâ, crassâ, lævi; spirâ brevi, obtusâ; suturis linearibus; anfractibus quatuor, planulatis; anfractu ultimo sub-angulato; basi lævi; callo lato, medio crasso; aperturâ ovato-quadratâ; columellâ curvatâ.

Shell orbicular, somewhat depressed, thick, smooth; spire short, obtuse; sutures linear; whorls four, flattened; last whorl sub-angulate; base smooth; callus wide, thick in the middle; mouth ovately quadrate; columella curved.

Length .05. Breadth .07 of an inch.

Remarks.—This little shell has no very striking characteristics, and yet cannot be confounded with any other of its congeners. It is unusually elevated for a Rotella.

R. CARINATA, PL. 36. FIG. 78.

R. testâ lenticulari, valde depressâ, tenuissimâ, lævi, politâ; spirâ brevissimâ, sub-ovatâ, obtusâ; suturis minimis, linearibus; anfractibus tribus, convexis, supernè planulatis; anfractu ultimo acutè angulato, carinato, basi lævi, politâ; callo parvo; aperturâ transversâ, ovali; columellâ latissimâ, curtâ.

Shell lenticular, very much depressed, very thin, smooth, polished; spire very short, sub-ovate, obtuse; sutures very small, linear; whorls three, convex, flattened above; last whorl acutely angulate, carinate; base smooth, polished; callus small; mouth transverse, oval; columella very wide, short.

Length .04. Breadth .11 of an inch.

Remarks.—The carina on the last whorl is very large. There is a corresponding depression in the interior of the mouth. Occasionally, there is an angulated line near the suture of the last whorl, but this is not a constant character. The carina is rather nearer the apex than the base of the shell. The substance is exceedingly thin, and has somewhat the appearance of ivory. On a front view, the general outline of the shell has a remarkably rhomboidal shape.

I know of no species of Rotella, except the following, which resembles this beautiful little shell.

R. LENTICULARIS, PL. 36. FIG. 79.

R. testâ lenticulari, depressâ, tenui, lævi, politâ; spirâ brevissimâ, sub-ovatâ, obtusâ; suturis parvis, linearibus; anfractibus quatuor, convexis; anfractu ultimo angulato; basi lævi; callo parvo; aperturâ sub-rotundâ; columellâ latâ, curvatâ.

Shell lenticular, depressed, thin, smooth, polished; spire very short, sub-ovate, obtuse; sutures small, linear; whorls four, convex; last whorl angulate; base smooth; callus small; mouth sub-rotund; columella broad, curved.

Length .04. Breadth .09 of an inch.

Remarks.—The angle on the last whorl is very variable. It sometimes amounts almost to a carina. The mouth is nearly round. The callus is slightly depressed below the surrounding surface.

This shell is, in part, allied to both the preceding species, but differs in the number of whorls, shape of the columella and spire, and the angle on the last whorl. They also differ much in thickness.

R. UMBILICATA, PL. 36. FIG. 80.

R. testâ orbiculari, valdè depressâ, crassâ, lævi, politâ; spirâ umbilicatâ; anfractibus occultis; anfractu ultimo rotundato, spiram tegente, ad suturam superiorem lineâ parvâ impressâ transversâ; basi lævi; callo magno, tenui, medio depresso; aperturâ rotundâ; columellâ latissimâ, subsulcatâ.

Shell orbicular, very much depressed, thick, smooth, polished; spire umbilicate; whorls concealed; last whorl rounded, covering the spire, with a small impressed transverse line near the superior suture; base smooth; callus large, thin, depressed in the middle; mouth rotund; columella very wide, sub-sulcate.

Length .05. Breadth .10 of an inch.

Remarks.—The columella has a shallow groove in its centre. The mouth is almost round.

This little shell, in general outline, is not unlike the R. nana, Lea, but the peculiar umbilicated spire will at once distinguish them.

This genus is quite rare in a fossil state. I believe that but one, the R. suturalis, has been found in the Tertiary beds of Europe. In this country the species appear to be more numerous.

GENUS TROCHUS.

T. ARMILLUS, PL. 37. FIG. 81.

T. testâ conicâ, elevatâ, crassiusculâ, imperforatâ, costatâ, striatâ; spirâ conicâ, acuminatâ; suturis minimis; anfractibus quinque, planis; costis transversis, tribus, noduliferis, alternantibus striis minimis; anfractu ultimo acutè angulato, carinato; basi valdè planulato, striis magnis et parvis; aperturâ quadrilaterali.

Shell conical, elevated, rather thick, imperforate, costate, striate; spire conical, acuminate; sutures very small; whorls five, flat; costæ transverse, three, noduliferous, alternating with very small striæ; last whorl acutely angular, carinate; base very much flattened, with large and small striæ; mouth quadrilateral.

Length .15. Breadth .18 of an inch.

Remarks.—The transverse ribs are generally noduliferous, but, in some cases, they are partially or even entirely smooth. The carina, on the last whorl, is always smooth. The striæ which alternate with the ribs are exceedingly small, so as to be invisible except with the aid of a powerful microscope. Those on the base are of various sizes. There are generally two large ones near the columella, and near the periphery, while those between are smaller. The base is unusually flat, and the mouth is quadrangular.

T. CONUS, PL. 37. FIG. 82.

T. testâ conicâ, crassâ, umbilicatâ, striatâ; spirâ sub-ovatâ, depressâ, obtusâ, ad apicem lævi; suturis latis, impressis; anfractibus sex, planulatis, ad suturam superiorem subcanaliculatis; striis transversis, impressis, parvis, crebris; anfractu ultimo angulato; basi striatâ; umbilico parvo, valdè profundo, striis duobus marginato; columellâ rectâ; aperturâ quadrilaterali, obliquâ.

Shell conical, thick, umbilicate, striate; spire sub-ovate, depressed, obtuse, smooth near the apex; sutures wide, impressed; whorls six, flattened, sub-canaliculate near the upper suture; striæ transverse, impressed, small, numerous; last whorl angulate; base striate; umbilicus small, very profound, margined with two striæ; columella straight; mouth oblique, quadrilateral.

Length .25. Breadth .35 of an inch.

Remarks.—The striæ of the base are rather larger than those on the upper part of the whorls. They increase as they approach the umbilicus, which is margined by two or three much deeper than the rest. They gradually become obsolete as they approach the apex, which is smooth. The umbilicus is not large, but very deep, so much so, indeed, as, apparently, to extend to the apex of the shell. It is continued downwards in a groove behind the columella. The mouth is nearly rhomboidal.

This species is closely allied to the T. eboreus, Wagner, from the Tertiary of S. Carolina, but the umbilicus and numerous striæ are sufficient to distinguish it.

T. LENS, PL. 37. FIG. 83.

T. testâ lenticulari, infernè et supernè depresso-conicâ, crassiusculâ, politâ, umbilicatâ, striatâ; spirâ brevissimâ, conicâ, minimè obtusâ; suturis latis, sub-profundis; anfractibus quatuor, planulatis, ad suturam superiorem canaliculatis; striis transversis, impressis, parvis, raris; anfractu ultimo acutè angulato, carinato; basi conicâ, striatâ; umbilico parvo, profundo, striis duobus profundis marginato; aperturâ quadrato-ovatâ.

Shell lenticular, depressed-conical above and below, rather thick, polished, umbilicate, striate; spire very short, conical, slightly obtuse; sutures wide, rather deep; whorls four, flattened, canaliculate at the upper sutures; striæ few, transverse, impressed, minute; last whorl acutely angular, carinate; base conical, striate; umbilicus deep, small, margined with two deep striæ; mouth quadrately ovate.

Length .10. Breadth .15 of an inch.

Remarks.—The unusually long base gives the shell the appearance of a double cone. The angle on the last whorl is about half way between the apex and the base. On the whorls of the spire, the striæ are two in number. There are three on the upper part of the last whorl, the lowest of which is the deepest. There is also a rib margining the lower part of the carina, making it appear double. The outer lip appears to be very fragile, as, out of four or five specimens now before me, not one has the mouth perfect. The whorls are perfectly flat, or even sometimes a little concave.

The peculiar lenticular form of this shell will at once distinguish it from all our other fossil species. The only one, indeed, to which it bears any resemblance is the T. reclusus. From this it differs chiefly in size, umbilicus, and columella.

T. TORQUATUS, PL. 37. FIG. 84.

T. testâ conicâ, acuminatâ, crassâ, politâ, perforatâ, crenulato-costatâ; spirâ sub-conicâ, depressiusculâ, obtusâ; suturis parvis; anfractibus quatuor, sub-convexis; costis transversis, quatuor, noduliferis; anfractu ultimo acutè angulato, carinato; basi crebrè et profundè striatâ; perforatione parvâ; aperturâ quadrangulari.

Shell conical, acuminate, thick, polished, perforate, crenulately costate; spire somewhat conical, rather depressed; obtuse; sutures small; whorls four, nearly flat; costæ transverse, four, noduliferous; last whorl acutely angular, carinate; base closely and profoundly striate; perforation small; mouth quadrangular.

Length .13. Breadth .12 of an inch.

Remarks.—The carina on the periphery of the last whorl is round and polished. There are three large, and one small nodulose costæ, the small one being next to the one nearest the upper suture.

This much resembles the T. armillus, herein described, but may be readily distinguished from that shell by its umbilicus, more ovate shape, and more striate base.

T. ARATUS, PL. 37. FIG. 85.

T. testâ ovato-conicâ, crassâ, politâ, imperforatâ, costatâ; spirâ depressâ, sub-ovatâ, obtusâ, ad apicem lævi; suturis parvis, linearibus; anfractibus tribus, sub-convexis; costis transversis, tribus, magnis, sub-noduliferis; anfractu ultimo angulato, costis quatuor; basi sulcatâ; aperturâ rotundâ.

Shell ovately conical, thick, polished, imperforate, costate; spire depressed, sub-ovate, obtuse, smooth near the apex; sutures small, linear; whorls three, slightly convex; costæ transverse, three, large, sub-noduliferous; last whorl angular, with four ribs; base sulcate; mouth round.

Length .08. Breadth .08 of an inch.

Remarks.—In the only specimen of this shell now before me, the two upper ribs are a little nodulous, while the two lower ones are smooth. As this is a variable character, it is probable that they may all be nodulous in other specimens. The additional one on the last whorl is almost large enough to be called a carina. The base is closely and deeply grooved. The mouth is perfectly round.

This shell is somewhat similar to the T. armillus, herein described, but is sufficiently distinguished by its more ovate form and round mouth.

T. RUFFINII, PL. 37. FIG. 86.

T. testâ conicâ, crassâ, costatâ, imperforatâ; spirâ elevatâ; suturis minimis, linearibus; anfractibus ——, infernè carinatis et sulcatis, supernè concavis et costatis; costis transversis, tribus, noduliferis, alternantibus striis minutissimis; anfractu ultimo angulato, bicarinato, carinâ superiore sub-crenulatâ; basi lævi; aperturâ transversâ, quadrilaterali; columellâ rotundatâ, lineâ impressâ marginatâ.

Shell conical, thick, costate, imperforate; spire elevated; sutures very small, linear; whorls ——, carinate and sulcate below, concave and costate above; costæ three, transverse, noduliferous, alternating with very minute striæ; last whorl angular, bicarinate; upper carina sub-crenulate; base smooth; mouth transverse, quadrilateral; columella rounded, margined by an impressed line.

Length ——. Breadth .38 of an inch.

Remarks.—The edge of the last whorl has two carinæ, or perhaps, more strictly speaking, a large carina with a deep groove in its centre. On the superior whorls, the upper carina and groove are alone visible. The transverse striæ are almost invisible to the

naked eye. The base is smooth, with the exception of two or three small striæ, immediately below the periphery of the whorl. As my only specimen is imperfect, I am unable to determine the dimensions or number of whorls.

The smooth base and peculiar rounded columella distinguish this shell from our other tuberculated fossil Trochi, some of which it much resembles.

This pretty little shell was sent to my father from the neighbourhood of Petersburg by E. Ruffin, Esq., whose name I have great pleasure in affixing to it as a slight token of respect for his zeal in elucidating the Geology of Virginia.

GENUS TURBO.

T. GLABER, PL. 37. FIG. 87.

T. testâ ovato-turbinatâ, elevatâ, tenui, umbilicatâ, lævi, nitente; spirâ elevatâ, rotundatâ; suturis parvis, linearibus; anfractibus ——, valdè convexis; anfractu ultimo rotundato; basi lævi; umbilico parvo; aperturâ ovatâ, supernè angulatâ, infernè rotundatâ; labro acuto.

Shell ovately turbinate, elevated, thin, umbilicate, smooth, polished; spire elevated, rounded; sutures small, linear; whorls ——, very convex; last whorl rounded; base smooth, umbilicus small; mouth ovate, angular above, rounded below; outer lip acute.

Length ——. Breadth .80 of an inch.

Remarks.—The umbilicus is small, and partially covered by an extension of the columella. The surface of the shell is glabrous, but not perfectly smooth, owing to inequalities in the growth, with occasional faint longitudinal lines. The mouth has a small internal channel-like impression where it meets the preceding whorl.

Having but one specimen of this shell, and that imperfect at the apex, I am unable to give its length or number of whorls. Of the latter, a little more than two remain, and about two or three must have been removed.

This shell bears so strong a resemblance to the recent Paludina vivipara, Auct., that were it not found among oceanic shells, I should have little hesitation in considering it as a variety of that species.

This shell is by far the largest of the genus as yet discovered in our Tertiary. It is unusually elevated in the spire for a Turbo.

T. RUSTICUS, PL. 37. FIG. 88.

T. testâ globoso-conicâ, crassâ, perforatâ, cancellatâ; spirâ conicâ, depressâ, acutâ; suturis parvis, linearibus; anfractibus quinque, planulatis; striis transversis crebris, magnis; striis longitudinalibus crebris, parvis; anfractu ultimo rotundato; basi striatâ transversè et alternatim; perforatione parvâ, angustâ; aperturâ quadrato-rotundatâ.

Shell globosely conical, thick, perforate, cancellate; spire conical, depressed, acute; sutures small, linear; whorls five, flattened; transverse striæ numerous, large; longitudinal striæ numerous, small; last whorl rounded; base striate transversely and alternately; umbilicus small, narrow; mouth quadrately rounded.

Length .12. Breadth .11 of an inch.

Remarks.—The transverse striæ on the upper part of the last whorl show a slight disposition to be alternate, and on the base they become entirely so. The whorls are sub-canaliculate at the upper sutures. The columella has a very slight incrassation at the base, but not sufficient to constitute the shell a Monadonta. The mouth is angular at the upper part of the columella, and round at the outer lip.

I can find none of our species of Turbo to which this pretty little shell can be referred. With the same number of whorls, it is hardly more than a fourth the size of the T. caperatus, Con., which it in some degree resembles. And, in our species, the transverse striæ are large, almost deserving the appellation of ribs, while in the T. caperatus they are described as small.

FAMILY CANALIFERIDÆ.

GENUS CERITHIUM.

C. CLAVULUS, PL. 37. FIG. 89.

C. testâ turritâ, valdè elevatâ, crassâ, costatâ, striatâ; spirâ acutâ, conicâ, valdè attenuatâ, mâmillatâ; suturis linearibus, sub-obsoletis; anfractibus ——, planis; costis tribus, transversis, magnis, sub-acutis, lævibus; striis longitudinalibus, raris, parvis; anfractu ultimo angulato; basi lævi; aperturâ quadratâ; canali brevi, minimè profundo.

Shell turrited, very elevated, thick, costate, striate; spire acute, conical, very attenuate, mamillate; sutures linear, almost obsolete; whorls ——, flat; ribs three, transverse, large, sub-acute, smooth; striæ longitudinal, small, infrequent; last whorl angular; base smooth; mouth quadrate; canal short, shallow.

Length ——. Breadth .15 of an inch.

Remarks.—The longitudinal striæ, from their size, although they do not cross the ribs, give the shell a cancellated appearance under the microscope. The mouth is nearly square. The body whorl has four instead of three striæ, a very small one being placed immediately below the angle.

This species bears a strong resemblance to the C. terebrale,* Adams, a recent shell from our coast, but it may be distinguished by having the transverse ribs fewer and more acute, the longitudinal striæ less frequent and larger, and the canal longer and less profound. It also approaches the Terebra constricta, Nob., but the ribs are more flattened, and the striæ less numerous and larger.

Although not thin, this shell is extremely fragile, as out of about fifty specimens I have not one full-grown one with the apex perfect. It attains a much larger size than that shown in the figure.

C. CURTUM, PL. 37. FIG. 90.

C. testâ elevato-conicâ, tenui, sub-cancellatâ, carinatâ, sub-perforatâ; spirâ breviusculâ, acutâ, ad apicem lævi; suturis excavatis; anfractibus sex, medio carinatis; striis transversis et sulcis longitudinalibus variabilibus; ultimo anfractu angulato; basi minutè striatâ; perforatione minimâ, aliquando obsoletâ; aperturâ ovatâ, supernè angulatâ, infernè valdè effusâ.

Shell elevated conical, thin, sub-cancellate, carinate, sub-perforate; spire rather short, acute, smooth at the apex; sutures excavated; whorls six, carinate in the middle; transverse striæ and longitudinal sulci variable; last whorl angular; base minutely striate; perforation very small, sometimes obsolete; mouth ovate, angular above, very effuse below.

Length .15. Breadth .06 of an inch.

Remarks.—The longitudinal sulci are very variable, being sometimes almost obsolete, while at others they give the shell a completely cancellate appearance, cutting the striæ

* As the name of this shell has been preoccupied, by Lamarck, for a fossil species from Grignon, I propose that the name of the discoverer be affixed to it, changing it to C. Adamsii. I find also that the name of the C. cancellatum, Nob., has been used by the same author. I, therefore, change it to C. spina.

and carina at right angles. The carina is placed immediately below the middle of the whorls, and, in some specimens, between it and the lower suture is another smaller one. When this latter is not present, it is replaced by a stria. Between the carina and upper suture there are generally two striæ, which vary in size. Those on the base are much smaller than those on the whorls. The sutures are small and triangular.

This shell is unusually short and thick for a Cerithium, and its effuse mouth has hardly the character of the canal of that genus.

C. DÆDALEUM, Pl. 37. Fig. 91.

C. testâ subulatâ, tenui, imperforatâ, costatâ, striatâ; spirâ attenuatâ, sub-ovatâ, mamillatâ, ad apicem lævi et politâ; suturis linearibus, parvis; anfractibus septem, planulatis; costis longitudinalibus, crebris, lævibus, planulatis; striis transversis, crebris, profundis; ultimo anfractu rotundato; basi striatâ, politâ; aperturâ arctatâ, sub-quadratâ, supernè angulatâ, infèrnè effusâ; labro acuto.

Shell subulate, thin, imperforate, costate, striate; spire attenuate, sub-ovate, mamillate, smooth and polished near the apex; sutures small, linear; whorls seven, flattened; striæ transverse, numerous, deep; costæ longitudinal, numerous, smooth, flattened; last whorl rounded; base striate, polished, mouth narrow, sub-quadrate; angulate above, effuse below; outer lip acute.

Length .15. Breadth .05 of an inch.

Remarks.—The sculpture of this shell is not unlike that of the Pasithea subula, herein described.

With this shell, as with the preceding, I feel in some doubt as to the genus to which it properly belongs.

C. moniliferum, Pl. 37. Fig. 92.

C. testâ subulatâ, sinistrali, crassâ, imperforatâ, costatâ; spirâ attenuatâ, conicâ; suturis minimis; anfractibus decem, planis; costis tribus, transversis, noduliferis, duabus extremis magnis, unâ medio parviore; anfractu ultimo rotundato; basi costis tribus, lævibus, transversis; aperturâ elongato-quadratâ; columellâ lævi, politâ; canale profundo, brevi.

Shell subulate, sinistral, thick, imperforate, costate; spire attenuate, conical; sutures very small; whorls ten, flat; costæ three, transverse, noduliferous, two extreme ones large, the middle one smaller; last whorl rounded; base with three transverse, smooth ribs; mouth elongately quadrate; columella smooth, polished; canal deep, short.

Length .22. Breadth .09 of an inch.

Remarks.—The middle costa is smaller than the two outer ones; it gradually decreases on the upper whorls, and finally becomes obsolete near the apex. The sutures are very small, and the whorls perfectly flat, so that it is difficult to determine their number.

This shell approaches the C. nigrocinctum, Adams, a recent species from our coast, but may be distinguished by its greater proportionate length, flatness of the whorls, and the difference between the size of the ribs. It is also allied to the C. perversum, another recent shell, but it is much smaller, and the ribs are strictly noduliferous, while in the C. perversum, they intersect longitudinal sulci. The three smooth basal costæ constitute another character peculiar, I believe, to this shell.

GENUS PLEUROTOMA.

P. lunatum, Pl. 37. Fig. 93.

P. testâ elongato-fusiformi, crassâ, glabrâ, nitente, imperforatâ, costatâ; spirâ attenuatâ, mamillatâ, ad apicem lævi; suturis flexuosis, minimis; anfractibus decem, medio angulatis, infernè convexis et costatis, supernè concavis et

sub-tuberculatis; costis longitudinalibus, sub-obliquis, magnis, rotundatis; anfractu ultimo rotundato; basi striis parvis, longitudinalibus; aperturâ arctato-ovatâ; columellâ rectâ, crassâ, politâ, superne valdè incrassatâ; sino profundo, lunato; canale brevi, inciso.

Shell elongately fusiform, thick, glabrous, shining, imperforate, costate; spire attenuate, mamillate, smooth at the apex; sutures flexuose, very small; whorls ten, angular near the middle, below convex and costate, above concave and subtuberculate; costæ longitudinal, somewhat oblique, large, rounded; last whorl rounded; base with small longitudinal striæ; mouth narrowly ovate; columella straight, thick, polished, very much incrassated above; sinus deep, crescent-shaped; canal short, incised.

Length 1.60. Breadth .50 of an inch.

Remarks.—The upper concave part of the whorls, near the suture, has a series of indistinct tubercles, generally large and but very little elevated. The costæ end a little below the middle of the last whorl, and the base is smooth, with the exception of a few longitudinal raised lines, and an indistinct oblique stria, which marks the growth of the canal. Behind the columella is a small groove, caused by its elevation above the neighbouring surface. The incrassation at the upper extremity of the columella forms a large callus, at the mouth of the sinus, and almost fills it up. This gives it its peculiar lunate appearance. There is, properly speaking, no canal. The base of the mouth is deeply incised, as in the genus Oliva, without cutting off the end of the columella as is usual in this class of shells.

This beautiful species agrees pretty well with the description and figure of P. limatula, Conrad, (Journal of the Academy, Vol. VI.) but is larger, tuberculate near the suture, and has the ribs more strongly developed. In addition to this, Mr. Conrad makes no mention of the peculiar lunate sinus which characterizes the shell now before us.

GENUS FASCIOLARIA.

F. PARVULA, Pl. 37. Fig. 94.

F. testâ fusiformi, crassâ, imperforatâ, nitente, sulcatâ, striatâ; spirâ elevatâ, obtusâ, ad apicem lævi; suturis profundis, arctatis; anfractibus septem, sub-convexis; sulcis longitudinalibus, magnis, crebris; striis transversis, parvis, raris; anfractu ultimo rotundato; basi profundè striatâ; aperturâ longâ, arctatâ, supra acutè angulatâ; columellâ multiplicatâ, canale longo, profundo, sub-curvato.

Shell fusiform, thick, imperforate, shining, sulcate, striate; spire elevated, obtuse, smooth near the apex; sutures deep, narrow; whorls seven, somewhat convex; sulci longitudinal, large, numerous; striæ transverse, small, few; last whorl rounded; base deeply striate; mouth long, narrow, acutely angular above; columella with many folds; canal long, deep, slightly curved.

Length .20. Breadth .08 of an inch.

Remarks.—On the superior whorls there are three small transverse striate near the upper suture, which cross the sulcations. The one nearest the suture is the largest and deepest. On the last whorl the sulcations end about the middle, and then, after a narrow interval, commence deep transverse striæ which increase as they approach the base. The folds on the columella are but continuations of these striæ. The aperture is very narrow and somewhat sinuous, gradually decreasing to the canal. The sutures are quite narrow and deep.

GENUS FUSUS.

F. PYGMÆUS, Pl. 37. Fig. 95.

F. testâ ovatâ, sub-fusiformi, crassâ, lævi, politâ; spirâ ovatâ, valdè obtusâ, breviusculâ; suturis linearibus; anfractibus quatuor, planulatis; anfractu ultimo rotundato; basi lævi; aperturâ sinuosâ, arctatâ; columellâ angulatâ; canale torto, longo.

Shell ovate, somewhat fusiform, thick, smooth, polished; spire ovate, very obtuse, rather short; sutures linear; whorls four, flattened; last whorl rounded; base smooth; mouth sinuose, narrow; columella angled; canal long, twisted.

Length .08. Breadth .05 of an inch.

Remarks.—This minute species is remarkably ovate. The canal is very long, and bent at several places. The apex is obtuse and sub-mamillate.

This shell, most probably, attains a greater size than that mentioned above, as the only specimen in my possession, bears evident marks of having had part of the last whorl broken off. This may also have given it its peculiar twisted canal.

F. ANOMALUS, PL. 37. FIG. 96.

F. testâ ovatâ, sub-fusiformi, perforatâ, tenui, lævi, politâ; spirâ sub-ovatâ, elevatâ, acutâ; suturis excavatis, latis; anfractibus quinque, convexis; anfractu ultimo rotundato; basi lævi; perforatione parvâ, arctâ; aperturâ sub-elliptică; columellâ brevi, tortâ; canale longo, minimè profundo, sinistrorsim reflecto.

Shell ovate, sub-fusiform, perforate, thin, smooth, polished; spire sub-ovate, elevated, acute; sutures excavated, wide; whorls five, convex; last whorl rounded; base smooth; perforation small, narrow; mouth sub-elliptical; columella short, twisted; canal long, very shallow, bent backwards towards the left.

Length .18. Breadth .10 of an inch.

Remarks.—There is a small canaliculation on the whorls near the upper part, which makes the sutures quite wide and deep. The umbilicus is very narrow, and almost hidden behind the columella. The canal is very peculiar, being folded round the base of the columella, until it extends nearly a third round the shell. There are faint traces of transverse striæ to be seen on some parts of the whorls.

It is not without some hesitation that I place this shell among the Fusi. It has not the straight deep canal which usually characterizes that genus, but in other respects it approaches it more nearly than any other. It may, perhaps, prove the type of a new genus.

FAMILY PURPURIDÆ.

GENUS BUCCINUM.

B. TUOMEYI, PL. 37. FIG. 97.

B. testâ ovato-fusiformi, crassâ, imperforatâ, striatâ; spirâ elevatâ, scalariformi; suturis impressis, profundis; anfractibus ——, sub-convexis, ad suturam superiorem angulatis; striis transversis, duplicatis, parvis, crebris; anfractu ultimo rotundato, infernè striis magnis et parvis alternantibus; basi longitudinaliter sulcatâ; aperturâ quadrangulari; canale longo, retorto; columellâ flexuosâ, infernè plicâ magnâ unâ.

Shell ovately fusiform, thick, imperforate, striate; spire elevated, scalariform; sutures impressed, deep; whorls ——, somewhat convex, angulate at the upper suture; striæ transverse, double, numerous, small; last whorl rounded, with large and small alternating striæ below; base longitudinally sulcate; mouth quadrangular; canal long, retorted; columella flexuose, with one large fold below.

Length ——, Breadth 1.40 inches.

Remarks.—On the upper part of the last whorl the striæ are in pairs with a minute impressed line between them having the appearance of double striæ. These, as they approach the base, pass gradually into alternating ones. The base, immediately behind the lower part of the columella, is marked with deep, somewhat semicircular, sulcations pointing the successive growth of the canal. The upper part of the columella is marked

by faint continuations of the striæ, not entirely obliterated by a thin deposite of callus. The canal is longer than is usual with the Buccina, and is bent somewhat backwards. The columella is much twisted. Close to the upper suture the whorls are bent, first at a right angle, and then downwards, descending gradually to the suture. Near the middle of the whorl, the striæ are faintest. As my only specimen is quite imperfect, I am unable to give the length or number of whorls; of these latter, portions of three remain, and there have probably been three or four more.

This fine shell is the largest of our fossil Buccina. Judging from description, it may bear a distant resemblance to the B. multirugatum, Conrad, but it differs in its straight striæ, size, want of an umbilicus, &c. It is quite rare. Mr. Tuomey whose name I have great pleasure in affixing to it, tells me that he has met with but two specimens of it, both imperfect.

B. PUSILLUM, PL. 37. FIG. 98.

B. testâ ovatâ, sub-conicâ, crassâ, sub-perforatâ, lævi; spirâ ovatâ, brevi, obtusâ; suturis parvis, linearibus; anfractibus quinque, sub-convexis; anfractu ultimo rotundato; basi lævi; perforatione minimâ; aperturâ ovatâ; columellâ rectâ.

Shell ovate, somewhat conical, thick, sub-perforate, smooth; spire ovate, short, obtuse; sutures small, linear; whorls five, slightly convex; last whorl rounded; base smooth; perforation very small; mouth ovate; columella straight.

Length .08. Breadth .04 of an inch.

Remarks.—This little shell bears a strong affinity to the recent B. lunatum, Say, but it is less ovate, and hardly a fifth the size of that shell.

B. FRUMENTUM, PL. 37. FIG. 99.

B. testâ ovato-fusiformi, acuminatâ, crassâ, perforatâ, lævi; spirâ conicâ, elevatâ, obtusâ; suturis parvis, linearibus; anfractibus quinque, convexis; anfractu ultimo rotundato, prope aperturam sub-undulato; basi lævi; perforatione parvâ; aperturâ acuminato ovatâ; canale brevi, obliquo; columellâ tortâ.

Shell ovately fusiform, acuminate, thick, perforate, smooth; spire conical, elevated, obtuse; sutures small, linear; whorls five, convex; last whorl rounded, slightly undulate near the mouth; base smooth; perforation small; mouth acuminate-ovate; canal short, oblique; columella twisted.

Length .15. Breadth .10 of an inch.

Remarks.—The undulations on the last whorl near the aperture are scarcely visible, and may be accidental.

This little shell has no very peculiar characteristics, but I cannot refer it to any described species.

B. QUADRULATUM, PL. 37. FIG. 100.

B. testâ ovato-conicâ, crassâ, imperforatâ, sulcatâ, costatâ; spirâ conicâ, sub-elevatâ, obtusâ, prope apicem lævi et politâ; suturis parvis, flexuosis; anfractibus sex, valdè convexis, prope suturam superiorem pene lævibus; sulcis longitudinalibus, latis, profundis; costis transversis, parvis, quadrangularibus, planulatis; anfractu ultimo rotundato; basi costatâ; aperturâ penè ellipticâ; columellâ curvatâ, truncatâ, infernè plicâ parvâ; canale obliquo.

Shell ovately conical, thick, imperforate, sulcate, costate; spire conical, somewhat elevated, obtuse, smooth and polished near the apex; sutures small, flexuose; whorls six, very convex, nearly smooth at the upper suture; sulci longitudinal, wide, deep; costæ transverse, small, quadrangular, flattened; last whorl rounded; base costate; mouth nearly elliptical; columella curved, truncate, with a small fold below; canal oblique.

Length .20. Breadth .12 of an inch.

Remarks.—The sulcations are unusually wide and close together, rendering the elevations between them acute. The ribs are four in number on the upper whorls, be-

sides a smaller one near the superior suture. They are perfectly quadrangular, having perpendicular sides and a flat top. When they cross the sulcations, they appear slightly nodulous. The spaces between them are about equal to them in width. Those on the base are closer and more acute. About three whorls of the apex are perfectly smooth.

This little species can be readily distinguished from its congeners by the peculiar shape of its transverse ribs.

GENUS NASSA.

N. IMPRESSA, PL. 37. FIG. 101.

N. testâ elongato-ovatâ, crassâ, imperforatâ, costatâ, striatâ; spirâ attenuatâ, conicâ, obtusâ, prope apicem lævi et politâ; suturis impressis, flexuosis; anfractibus septem, convexis, ad suturam superiorem angulatis; costis longitudinalibus, latis, rotundatis; striis transversis, parvis, flexuosis; anfractu ultimo rotundato; basi striatâ; aperturâ sub-ellipticâ; canale brevi, obliquo; labro intus minutè dentato.

Shell elongately ovate, thick, imperforate, costate, striate; spire attenuate, conical, obtuse, smooth and polished near the apex; sutures impressed, flexuose; whorls seven, convex, angular near the upper suture; costæ longitudinal, wide, rounded; striæ transverse, flexuose, small; last whorl rounded; base striate; mouth sub-elliptical; canal short, oblique; outer lip minutely dentate within.

Length .20. Breadth .11 of an inch.

Remarks.—The transverse striæ are small and abrupt; they cross the ribs. There is one rather deeper than the rest on the angle of the whorls, above this is a very small one, and between this and the suture the surface is smooth. The costæ are very large and wide, generally rounded, but occasionally somewhat angular. The three first whorls of the spire are smooth. There are two or three teeth of various sizes on the inside of the outer lip.

This little shell differs in various respects from all of our other species of Nassa. It is more elevated than is usual with the genus. The striæ are fewer and the costæ larger than in the recent N. alba, Say, to which, in sculpture, it bears some resemblance.

FAMILY COLUMELLIDÆ.

GENUS MARGINELLA.

M. CONULUS, PL. 37. FIG. 102.

M. testâ obovatâ, conoidali, crassâ, lævi, politâ; spirâ conicâ, obtusâ; suturis sub-obsoletis; anfractibus tribus, planis; anfractu ultimo rotundato; basi lævi; aperturâ longâ, arctatissimâ; columellâ infernè plicis tribus; labro incrassato, rotundato, lævi.

Shell obovate, conoidal, thick, smooth, polished; spire conical, obtuse; sutures nearly obsolete; whorls three, flat; last whorl rounded; base smooth; mouth long, very narrow; columella with three folds near the base; outer lip thickened, rounded, smooth.

Length .12. Breadth .08 of an inch.

Remarks.—The whorls of the spire are very small, and the sutures almost obliterated, so that they can scarcely be seen except on a perpendicular view. The folds on the columella are very near the base, and quite small. The shape of the mouth is almost linear.

This shell is more nearly allied to the M. incurva, Lea, than to any other, but differs in the number of the folds on the columella, and the incrassation of the outer lip.

M. EXILIS, PL. 37. FIG. 103.

M. testâ acuminato-ellipticâ, compressâ, tenui, lævi, politâ; spirâ attenuatâ, obtusâ, ovatâ; suturis obsoletis; anfractibus——, planis; anfractu ultimo rotundato; basi lævi, acuminatâ; aperturâ angustâ, ovatâ; columellâ plicis quatuor; labro acuto, intus costâ longitudinali.

Shell acuminately elliptical, compressed, thin, smooth, polished; spire attenuate, ovate, obtuse; sutures obsolete; whorls ——, flat; last whorl rounded; base smooth, acuminate; mouth narrow, ovate; columella with four folds; outer lip acute, with a longitudinal costa within.

Length .18. Breadth .10 of an inch.

Remarks.—The spire is covered with a smooth porcelain-like deposite, which obliterates the sutures, and renders it impossible to determine the number of whorls. The most peculiar character about this shell is the internal rib, near the edge of the outer lip,

FAMILY CONVOLUTIDÆ.

GENUS OLIVA.

O. CANALICULATA, PL. 37. FIG. 104.

O. testâ cylindraceâ, crassâ, lævi, nitidâ; spirâ exsertâ, obtusâ, scalariformi; anfractibus quinque, angulatis, prope suturam inferiorem incrassatis; suturis valdè profundis, latis, canaliculatis; basi acuminatâ, striis raris, parvis, transversis; aperturâ lineari, supernè valdè incisâ, infernè emarginatâ; columellâ multiplicatâ; labro acuto.

Shell cylindrical, thick, smooth, shining; spire exserted, obtuse, scalariform; whorls five, angular, incrassated near the lower suture; sutures very deep, wide, canaliculate; base acuminate, with a few small transverse striæ; mouth linear, deeply incised above, emarginate below; columella with many folds; outer lip acute.

Length 1.60. Breadth .70 of an inch.

Remarks.—The line of incrassation on the lower part of the whorls, is wanting on the last one. To those of the spire, it gives a peculiar bullate appearance. The sutures are larger and deeper than in any other of the genus. The outer lip is attached to the body of the shell only by a small transverse plate, near its upper extremity, which causes the peculiar suture. This plate does not extend to the edge of the lip.

There is a specimen of this shell, without a name, in the collection of the Academy of Natural Sciences of Philadelphia. I am surprised that it has not been heretofore described, as it is a remarkable shell and by no means rare. It has hitherto, I believe, been confounded with one of our recent species, which it distantly resembles.

O. ANCILLARIÆFORMIS, PL. 37. FIG. 105.

O. testâ ovato-cylindraceâ, tenui, lævi, politâ; spirâ subulatâ; suturis canaliculatis; anfractibus ——, planis; anfractu ultimo rotundato; basi lævi; aperturâ sub-triangulari, effusâ, minimè incisâ; columellâ striis nullis, infernè varicè parvo; labro acuto.

Shell ovate-cylindrical, thin, smooth, polished; spire subulate; sutures canaliculate; whorls ——, flat; last whorl rounded; base smooth; mouth sub-triangular, effuse, very slightly incised; columella with no striæ, a small varix below; outer lip acute.

Length .25. Breadth .10 of an inch.

Remarks.—On one of my specimens there is a deep narrow groove immediately below the upper suture. As it exists only on this specimen, and there but at intervals, I suppose it to be merely a fortuitous character. The mouth is acutely angular above and wide below.

The peculiar conformation of the columella and base of the mouth seem to place this shell among the Ancillariæ, but its sutures and naked spire separate it from that genus.

ARTICLE X.

Description of New Fresh Water and Land Shells. By Isaac Lea. Read August 18, 1843.

Heretofore, very little examination of the rivers and lakes of Florida has been made for the *mollusca* inhabiting them, two or three *Uniones* only having been described from that territory. Recently, I have been fortunate enough to obtain, through the kindness of Dr. Budd, of New York, a number of specimens which were collected by Mr. Samuel B. Buckley, and sent to him. Among them I found only two species before described—the *Unio Blandingianus*, (Nobis,) and *Unio modioliformis*, (Nobis.) The number of new ones proposed in this paper, from that territory, is nine species of *Uniones*. The remainder, from other localities, I owe to the kindness of various friends.

Unio amygdalum, Pl. 39. Fig. 1.

Testâ obovatâ, subinflatâ, valdè inæquilaterali, posticè rotundatâ; valvulis subtenuibus; natibus prominentibus; epidermide politâ, radiatâ; dentibus cardinalibus parvis; lateralibus sublongis curvisque; margaritâ albâ et valdè iridescente.

Shell obovate, somewhat inflated, very inequilateral, rounded behind; valves rather thin; beaks somewhat prominent; epidermis polished, smooth; cardinal teeth small; lateral teeth rather long and curved; nacre white and very iridescent.

Hab. Lake George, Florida. S. B. Buckley.

My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .5, Length .9, Breadth 1.3 inches.

Shell obovate, somewhat inflated, very inequilateral, rounded and compressed behind; umbonial slope rounded; substance of the shell rather thin; beaks somewhat prominent; ligament very short and thin; epidermis smooth and polished, with numerous green rays covering the whole disk; cardinal teeth small, single in the right and double in the left valve; lateral teeth rather long and curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed above the centre of the cavity of the beaks; cavity of the shell deep and rounded; cavity of the beaks rather deep and angular; nacre beautifully pearly and highly iridescent.

Remarks.—This is a small and uncommonly beautiful species. The two specimens before me vary but little in size. They seem to be adult—are about the size of *Unio glans*, (Nobis,) but differ from it entirely in the nacre, in having rays and in being obovate. The epidermis is yellow, but the numerous and close rays which cover the

whole disk give it a dark appearance, particularly on the posterior part. The beaks being eroded, I am unable to give their characters, but there is an appearance of obsolete undulations.

Unio Buckleyi, Pl. 39. Fig. 2.

Testâ ellipticâ, inflatâ, valdè inæquilaterali, posticè angulatâ; valvulis crassis; natibus subprominentibus; epidermide tenebroso-fuscâ; dentibus cardinalibus magnis crassisque; lateralibus longis curvisque; margaritâ purpureâ vel salmonis colore tinctâ.

Shell elliptical, inflated, very inequilateral, angular behind; valves thick; beaks rather prominent; epidermis dark-brown; cardinal teeth large and thick, lateral teeth long and curved; nacre purple or salmon-coloured.

Hab. Lake George and Lake Monroe, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. 1.5, Length 2, Breadth 3.7 inches.

Shell elliptical, inflated, very inequilateral, angular behind; substance of the shell thick; beaks rather prominent; ligament long and rather thick; epidermis dark-brown, smooth, and shining, with obscure green rays in the young; cardinal teeth large and thick, single in the right and double in the left valve; lateral teeth long, thick, and slightly curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed above the centre of the cavity of the beaks; cavity of the shell rather deep; cavity of the beaks rather deep; nacre purple or salmon-coloured.

Remarks.—A number of specimens of this species are before me, and they present many different forms, differing in many respects as the varieties of the *U. complanatus* do from each other. The prevailing colour of the nacre, which is very brilliant, is salmon, but many are purple—two only are white. The epidermis of all the older specimens is dark-brown—some nearly black, and without rays; the younger are smooth and polished on the outside, with numerous obscure green rays, darker on the posterior slope. The general outline, in most specimens, is like that of *U. Batavus*, (Lam.,) but some individuals approximate to that of *U. ovalis*, (Flem.)

Unio minor, Pl. 39. Fig. 3.

Testâ ellipticâ, subinflatâ, valdè inæquilaterali, posticè rotundatâ; valvulis crassis; natibus subprominentibus; epidermide striatâ, subnigrâ; dentibus cardinalibus subgrandibus; lateralibus parvis curvisque; margaritâ albâ et iridescente.

Shell elliptical, rather inflated, very inequilateral, rounded behind; valves thick; beaks rather prominent; epidermis striate, nearly black; cardinal teeth rather large; lateral teeth small and curved; nacre white and iridescent.

Hab. Lake Monroe and Lake George, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .4, Length .6, Breadth .9 of an inch.

Shell elliptical, rather inflated, very inequilateral, rounded behind; umbonial slope rounded; substance of the shell thick, thinner behind; beaks rather prominent; ligament very short and thin; epidermis closely striate, nearly black; cardinal teeth rather large; lateral teeth small and curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed above the centre of the cavity of the beaks; cavity of the shell deep; cavity of the beaks rather deep and angular; nacre pearly white and iridescent.

Remarks.—This is an interesting species, rather smaller than the *U. parvus*, (Barnes,) and very closely resembling it in most of its characteristics. Like it, the epidermis is dark and roughly striate. It differs in form in not being transverse, but inclining to be obovate—also apparently being devoid of the singularly beautiful undulations of the beaks of the *parvus*. I am not, however, positive on this subject, as the three specimens submitted to my examination are all slightly eroded at the beaks. The position and form of the dorsal cicatrices differ. In the *parvus* they form a row across the cavity of the beaks.

On a close examination of the region of the anterior cicatrices, may be observed a third distinct cicatrix, placed on the side of the anterior portion of the cardinal tooth. Nearly the same position of a cicatrix was observed and described in the *U. cucumoides*, (Nobis.) Trans. Am. Phil. Soc., vol. viii. p. 193.

Unio fuscatus, Pl. 40. Fig. 4.

Testâ ellipticâ, subinflatâ, valdè inæquilaterali, posticè biangulatâ; valvulis tenuibus; natibus vix prominentibus; epidermide tenebroso-fuscâ, obsoletè radiatâ; dentibus cardinalibus parvis; lateralibus sublongis subrectisque; margaritâ cupreâ.

Shell elliptical, rather inflated, very inequilateral, biangular behind; valves thin; beaks slightly prominent; epidermis dark-brown, obsoletely radiated; cardinal teeth small; lateral teeth rather long and nearly straight; nacre copper-coloured.

Hab. Black Creek, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .5, Length .9, Breadth 1.7 inches.

Shell elliptical, rather inflated, very inequilateral, biangular behind; umbonial slope subangular; valves thin; beaks slightly prominent; ligament rather short and thin; epidermis dark-brown—with numerous small obscure green rays, more distinct on the umbones; cardinal teeth small, disposed to be double in both valves; lateral teeth rather long, thin, and nearly straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed under the anterior of the lateral tooth. Cavity of the shell rather shallow; cavity of the beaks small and subangular. Nacre copper-coloured and iridescent.

Remarks.—This species somewhat resembles *Unio pusillus*, (Nobis,) but may at once be distinguished by the absence of the sharp angle of the umbonial slope of that shell, and the distinct angle of its posterior margin.—It differs also in the colour of the nacre. The *fuscatus* is dark on the posterior slope, and compressed at the posterior portion of the shell. The minute rays, which are nearly lost in the dark hue of the epidermis, are closer and more distinct towards the beaks. Neither of the three specimens before me are perfect at the beaks, and I am therefore unable to say whether the tips are undulated in this species.

Unio Buddianus, Pl. 40. Fig. 5.

Testâ oblongâ, compressâ, inæquilaterali, posticè subbiangulatâ; valvulis subcrassis; natibus subprominentibus; epidermide subnigrâ; dentibus cardinalibus magnis lamellatisque; lateralibus perlongis subrectisque; margaritâ purpureâ et iridescente.

Shell oblong, compressed, inequilateral, subbiangular behind; valves rather thick; epidermis almost black; cardinal teeth large and lamellar; lateral teeth long and nearly straight; nacre purple and iridescent.

Hab. Lake George and Lake Munroe, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. 1.3, Length .2, Breadth 3.9 inches.

Shell oblong, compressed, inequilateral, subbiangular behind; substance of the shell rather thick; beaks rather prominent; ligament long and rather thick; epidermis almost black, smooth on the superior part of the disk; cardinal teeth large and lamellar, single in the right and double in the left valve; lateral teeth long and nearly straight; anterior cicatrices distinct, posterior cicatrices confluent; dorsal cicatrices in the centre of the cavity of the beaks; cavity of the shell shallow; cavity of the beaks small; nacre purple and very iridescent.

Remarks.—But two individuals of this species are before me, one of which is much younger than the other. In outline and general characteristics it resembles *U. complanatus.* It will, no doubt, be found with white and salmon-coloured nacre. In the larger specimen the anterior dorsal margin is somewhat truncate, and there is a like disposition in the younger one.

Unio trossulus, Pl. 40. Fig. 6.

Testâ obliquâ, cuneatâ, inflatâ, valdè inæquilaterali; posticè subangulatâ; valvulis crassis; natibus prominulis, undulatis; epidermide nitidâ, luteâ, radiatâ; dentibus cardinalibus parvulis; lateralibus rectis subbrevibusque; margaritâ albâ et valdè iridescente.

Shell oblique, wedge-shaped, inflated, very inequilateral, subangular behind; valves thick; beaks somewhat prominent, undulated; epidermis polished, yellow, radiated; cardinal teeth rather small; lateral teeth straight and rather short; nacre white and very iridescent.

Hab. Monroe Lake, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .6, Length .8, Breadth 1.4 inches.

Shell oblique, wedge-shaped, inflated, very inequilateral, subangular behind; umbonial slope rounded; substance of the shell thick; beaks somewhat prominent, and beautifully undulated at the tip; ligament short and very thin; epidermis smooth, polished, yellow, with dark green rays on the posterior portion; cardinal teeth rather small, double in both valves; lateral teeth straight and rather short; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed across the cavity of the beaks; cavity of the shell rather deep and rounded; cavity of the beaks small and subangular; nacre pearly white and beautifully iridescent.

Remarks.—A single individual only of this beautiful and distinct little species is before me. It has somewhat the form of *Unio Troostensis,* (Nobis,) but may easily be distinguished from that species by its rays, and the undulations of the beaks. In this specimen the anterior portion is yellow with obsolete rays, the posterior portion is dark-green with closely set rays, which are, near the margin, so intense as to give a beautiful deep green border to the interior margin. The undulations of the beaks are numerous, beautifully regular, and double. The nacre is very unusually pearly and brilliant. There is a third distinct cicatrix, resembling that in the *U. minor,* herein described. The

trossulus has some resemblance to the *amygdalum*, herein described, being nearly of the same size. The latter, however, is a thinner shell, is not oblique, and the rays are distinct over the whole disk.

Unio occultus, Pl. 41. Fig. 7.

Testâ ellipticâ, compressâ, inæquilaterali, posticè subbiangulatâ; valvulis tenuibus; natibus subprominentibus undulatisque; epidermide nitidâ, tenebroso-fuscâ, obsoletè radiatâ; dentibus cardinalibus subgrandibus; lateralibus longis subcurvisque; margaritâ purpureâ et iridescente.

Shell elliptical, compressed, inequilateral, subbiangular behind; valves thin; beaks somewhat prominent and undulated; epidermis polished, dark-brown, and obscurely radiated; cardinal teeth rather large; lateral teeth long and somewhat curved; nacre purple and iridescent.

Hab. Black Creek and Lake Monroe, Florida. S. B. Buckley.

My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .8, Length 1.2, Breadth. 2.1 inches.

Shell elliptical, compressed, inequilateral, subbiangular behind; umbonial slope slightly angular; substance of the shell thin; beaks somewhat prominent and minutely undulated at the tip; ligament long and thin; epidermis smooth and polished, dark-brown, with obscure rays over the whole disk; cardinal teeth rather large, and disposed to be double in both valves; lateral teeth long, rather thin, and somewhat curved; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices under the plate posterior to the cardinal tooth; cavity of the shell shallow; cavity of the beaks small and subangular; nacre purple and iridescent.

Remarks.—The three specimens before me vary but little in size or form, and are all purple—others may differ in colour. It is rather a diminutive species, allied to *complanatus*, but may easily be distinguished from that shell. The epidermis being filled with dark-green rays over the whole disk, gives it a very dark hue. In the more perfect individuals, the exterior is very smooth and highly polished.

Unio Monroensis, Pl. 41. Fig. 8.

Testâ ellipticâ, subcompressâ, inæquilaterali, posticè subangulatâ; valvulis crassis; natibus prominulis; epidermide rufo-fuscâ; dentibus cardinalibus parvulis; lateralibus longis, lamellatis curvisque; margaritâ lividâ et iridescente.

Shell elliptical, rather compressed, inequilateral, somewhat angular behind; valves thick; beaks somewhat prominent; epidermis reddish-brown; cardinal teeth rather small; lateral teeth long, lamellar, and curved; nacre livid and iridescent.

Hab. Lake Monroe, Florida. S. B. Buckley.

My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. 1.1, Length 1.7, Breadth 2.8 inches.

Shell elliptical, rather compressed, inequilateral, somewhat angular behind; umbonial slope angular; substance of the shell thick, thinner behind; beaks somewhat prominent; ligament rather long and thick; epidermis smooth, dark-reddish brown, nearly black on the posterior slope; cardinal teeth rather small, disposed to be double in both valves; lateral teeth long, lamellar, and curved; anterior cicatrices distinct; posterior cicatrices distinct; dorsal cicatrices placed under the anterior end of the lamellar tooth; cavity of the shell rather shallow; cavity of the beaks rather deep and angular; nacre livid and iridescent.

Remarks.—A single specimen only of this species is before me.—Other specimens may vary in some characters. It is most nearly allied to *U. crassidens*, (Lam.,) but is a shorter species, and not so thick. The purple and white colour of the nacre in this specimen gives it a livid appearance—other specimens may be found of a salmon colour. It has a fine nacre with a blackish margin. No rays are visible on this specimen.

Unio aheneus, Pl. 41. Fig. 9.

Testâ valdè transversâ, compressâ, valdè inæquilaterali, posticè biangulatâ; valvulis tenuibus; natibus vix prominentibus, undulatis; epidermide tenebroso-fuscâ, radiatâ; dentibus cardinalibus minimis; lateralibus longissimis rectisque; margaritâ cupreâ.

Shell very wide, compressed, very inequilateral, biangular behind; valves thin; beaks scarcely prominent, undulated; epidermis dark-brown and rayed; cardinal teeth very small; lateral teeth very long and straight; nacre copper-coloured.

Hab. Black Creek, Florida. S. B. Buckley.
My cabinet and cabinets of Dr. Budd and Mr. Buckley.

Diam. .5, Length .9, Breadth 2.1 inches.

Shell very wide, compressed, very inequilateral, biangular behind; umbonial slope angular and straight; substance of the shell very thin; beaks scarcely prominent, undulated at the tip; ligament very long and thin; epidermis dark-brown, with numerous dark-green oblique rays on the whole disk; cardinal teeth very small and granulate; lateral teeth very long, thin, and straight; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed under the anterior end of the lateral tooth; cavity of the shell shallow; cavity of the beaks very small and angular; nacre dark copper-colour and iridescent.

Remarks.—This is a very distinct species, belonging to that group of which the *complanatus* may be considered to be the type. It is remarkable for its dark copper-coloured nacre, which is very splendent. Indistinct undulations may be observed at the tip of the beaks, although the specimens are both eroded there. The cardinal teeth are remarkable in being so small and in being granular, and the position of the dorsal cicatrices is farther removed from the cardinal tooth than usual—even more so than in the *Unio Shepardianus*, (Nobis.) The posterior slope is elevated, compressed, and made very dark by thick green rays. The flattening behind the umbonial slope causes a second angle at the posterior margin.

Unio neglectus. Pl. 42. Fig. 10.

Testâ oblongâ, inflatâ, inæquilaterali; valvulis tenuibus; natibus subprominentibus; epidermide luteolâ, radiatâ; dentibus cardinalibus parvis; lateralibus longis, tenuibus subcurvisque; margaritâ subaureâ et iridescente.

Shell oblong, inflated, inequilateral; valves thin; beaks rather prominent; epidermis yellowish, rayed; cardinal teeth small; lateral teeth long, thin, and somewhat curved; nacre somewhat golden and iridescent.

Hab. North Alabama. Dr. Budd.
My cabinet and cabinet of Dr. Budd.

Diam. .8, Length 1.2, Breadth 2 inches.

Shell oblong, inflated on the umbonial slope, which is rounded; substance of the shell very thin, thicker before; beaks rather prominent; ligament rather long and thin; epidermis yellow, inclining to saffron, with rather numerous indistinct green rays, more dense on the posterior portion; cardinal teeth small, tuberculate, single in the right and double in the left valve; lateral teeth long, thin, and somewhat curved; anterior cicatrices confluent; posterior cicatrices confluent; dorsal cicatrices placed under the cardinal tooth; cavity of the shell deep and rounded; cavity of the beaks shallow and angular; nacre somewhat golden-coloured and very iridescent.

Remarks.—A single specimen of this shell was given to me last winter by Dr. Budd, of New York, and I have delayed the description in the hope of having others for comparison. In its exterior form and appearance, it resembles the *Margaritana marginata* —but its teeth at once distinguish it from that species. The cardinal teeth are remarkably small, being little more than tubercles.

Unio superbus. Pl. 42. Fig. 11.

Testâ alatâ, triangulari, valdè inflatâ, valdè inæquilaterali; valvulis subcrassis; natibus elevatis; epidermide tenebroso-fuscâ; dentibus cardinalibus perlongis lamellatisque; lateralibus longis, lamellatis curvisque; margaritâ aureâ et valdè iridescente.

Shell winged, triangular, very much inflated, very inequilateral; valves rather thick; beaks elevated; epidermis dark-brown; cardinal teeth very long and lamellar; lateral teeth long, lamellar, and curved; nacre golden and very iridescent.

Hab. New Holland. J. C. Jay, M.D.

My cabinet and cabinet of Dr. Jay.

Diam. 1.9, Length 3. Breadth 3.6 inches.

Shell winged, triangular, very much inflated, very inequilateral; substance of the shell rather thick, thinner behind; beaks elevated, rounded; ligament very long and rather thin; epidermis dark-brown, with three obscure rays on the posterior slope; cardinal teeth very long, *double* in the right and *single* in the left valve; lateral teeth long, lamellar, and curved; anterior cicatrices confluent; posterior cicatrices confluent; dorsal cicatrices nearly concealed under the plate between the cardinal and lateral teeth; cavity of the shell very deep and rounded; cavity of the beaks very deep and angular; nacre pale golden, brilliant, and iridescent.

Remarks.—I owe to the kindness of Dr. Jay the possession of this beautiful and rare *Unio.* Several of its characteristics are very remarkable; its long cardinal teeth being reversed, the double one being in the right valve and the single one in the left. The nacre is unusually rich and splendid. The beaks of the specimen before me are eroded, but they are perfect enough to observe that the tips must have been thickly set with minute undulations, probably radiating and not concentric. In outline, it has some resemblance to *Unio purpuratus*, (Lam.,) but is more triangular and more inflated.

Dr. Jay received this species from a correspondent in New Holland, accompanied with the *Unio delphinus*, (Nobis.) The latter species does not, however, I believe, exist on that island, but on the coast of Malacca, in the river Souzi, the locality given to me when I described it being erroneous.

Unio aratus, Pl. 42. Fig. 12.

Testâ ellipticâ, crebrè et transversè sulcatâ, subcompressâ, inæquilaterali, posticè angulatâ; valvulis subcrassis; natibus prominulis; epidermide pallido-luteâ; dentibus cardinalibus subgrandibus; lateralibus longis curvisque; margaritâ albâ.

Shell elliptical, closely and transversely furrowed, rather compressed, inequilateral, angular behind; valves rather thick; beaks somewhat prominent; epidermis pale-yellow; cardinal teeth rather large; lateral teeth long and curved; nacre white.

Hab. . . . . .

My cabinet.

Diam. .3, Length .5, Breadth .7 of an inch.

Shell elliptical, thickly, regularly, and transversely furrowed, rather compressed, inequilateral, angular behind; umbonial slope rounded; posterior slope with two raised curved lines extending from the beak to the posterior margin; substance of the shell rather thick; beaks somewhat prominent; ligament very short and very thin; epidermis pale-yellow over the whole disk, and without any appearance of rays; cardinal teeth rather large and disposed to be double in both valves; lateral teeth long and curved; anterior cicatrices distinct; posterior cicatrices distinct; dorsal cicatrices placed across the centre of the cavity of the beaks; cavity of the shell rather shallow; cavity of the beaks rather shallow and angular; nacre white.

Remarks.—A very remarkable little shell which may prove to be rather a young individual. The regular, transverse, closely-set furrows over the whole disk are very striking, it being the first species which I have seen with this perfect characteristic. The beaks are somewhat eroded, and I do not observe any undulations on them. Small ones may, perhaps, occur on perfect specimens. It seems to be somewhat allied to *Unio stramineus*, (Conrad,) but it differs somewhat in outline, and that species is not regularly furrowed, but rather transversely wrinkled, and is rather a large species, with beautiful undulations at the tip of the beaks.

The habitat of this shell is not known. The person from whom I procured it could not even inform me whether it was exotic or not.

ARTICLE XI.

Observations made in the years 1838, '39, '40, '41, '42, *and* '43, *to determine the Magnetical Dip and the Intensity of Magnetical Force, in several parts of the United States. By John Locke, M.D., Professor of Chemistry and Pharmacy in the Medical College of Ohio. Read April* 19, 1844.

POPULAR EXPLANATION OF THE ELEMENTS OF TERRESTRIAL MAGNETISM.

In endeavouring to ascertain, by experiment, the elements of terrestrial magnetism, the operator proceeds, without reference to any theory, to determine them as the values of a *simple force* acting in a certain direction, regardless of what may be the nature or cause of that force. The nature of the research will be understood, by referring to the investigation of a similar force, namely, gravitation, which has likewise been examined as a simple force. The points of inquiry lie in the quantity of that force, and the direction in which it acts. By this investigation of gravitation, the following facts have been ascertained:

1. That gravitation is not uniform over all parts of the earth, but is less towards the equator than towards the poles.

2. That it is less in high than in low situations.

3. That it acts perpendicularly to the surface of the sea, and in general perpendicularly to the surface of the earth; but as the earth is not spherical, but spheroidal, and a section of it is an ellipse, gravitation does not tend towards the centre, except at the equator and at the poles; the point of convergence for regions near the equator being nearer than the centre, and for regions near the poles, farther than the centre.

4. That a mountain will, at a certain rate, in proportion to its mass and proximity, deflect the course of gravitation, and cause the lower end of a plumb line to lean towards it.

5. That the moon, sun, and planets, have an influence on the direction and force of gravitation, that influence depending on the mass, direction, and distance of the said bodies.

And, finally, there has been deduced the admirable Newtonian law: *That gravitation is a mutual force, acting, between all of the particles of matter in the universe, increasing directly as the quantity of matter, but diminishing, like other radiants, as the squares of*

the distance increase. This simple law, it is commonly known, lies at the foundation of the whole of physical astronomy, and is that law which renders it a perfect science.

The objects of the "magnetic crusade," as it has been called, have been:

1. To examine, as far as possible, all of the circumstances and conditions of this peculiar force, called magnetism, in all parts of the globe; and,

2. To endeavour to deduce, from the results, some law or laws which shall, like the above laws of gravitation, embrace all the phenomena, and, like that law, enable us to predict, not only the present condition of that force at any particular place, but its condition at any future time, and all of the intermediate revolutions which it may have undergone.

Magnetism, as a force, is identical with any other force, but it differs from gravitation in regarding, chiefly, one kind of matter only, and that matter in a peculiar condition, namely, ferruginous matter, possessing polarity.

The earth, all over its surface, and to the greatest heights and depths accessible to man, has the property of attracting a magnetized body, and of directing its polar axis in a particular course, and this property is called terrestrial magnetism. The elements of terrestrial magnetism, considered as a simple force, are only two; namely, the quantity or intensity of that force, and the direction in which it acts. But, in reference to other fixed lines and planes of position, we enumerate four elements of terrestrial magnetism. The planes to which these elements are referred are astronomical ones, the horizon and the meridian, and the line which they form by their intersection, the meridian line of any place. These four elements of magnetism are,

1. The variation or declination of the compass.
2. The horizontal intensity of force.
3. The dip or inclination.
4. The total intensity of force.

Of the Declination.—It is well known that the needle of the common compass does not, in all places, point to the true north, but makes an angle with the meridian greater or less, in one region, declining to the east, and, in another, to the west. This angle which the needle makes with the meridian line, is called the declination. A line on the chart accompanying this paper, called the "line of no variation," is traced from the lower end of Lake Superior, along the western shore of Lake Huron, across Lake Erie, and thence to the coast of North Carolina, passing through the places at which the needle will coincide with the meridian, and point to the true pole. In the parts of the United States to the eastward of this line, the declination or variation is westward, and, in parts to the westward of said line, it is eastward.

Of the Horizontal Intensity of Force.—The common compass needle is moved to the position which it finally occupies, by a certain force not in all places the same; which force, if it be drawn out of the line which it inclines to occupy, will bring it back again with a velocity proportionate to that force. This is called the horizontal intensity of force. It may be measured and compared by means of the number of vibrations which the same needle, deflected a few degrees from its course, will perform in a given time.

Of the Dip or Inclination.—The ordinary compass needle is so pivoted, above the centre of gravity, that it is compelled to move in the horizontal plane; but if it could move freely in a vertical plane, as a cannon can be elevated or depressed on its trunnions, it would not, in our latitude, remain horizontal, but the north end would descend, making an angle of about seventy degrees with the horizon. This angle, which a free needle would make with the horizon, is called the DIP or INCLINATION. At some point near the equator, the dip is nothing, and beyond that, to the south, the south end of the needle dips or descends below the level.

Of the Total Intensity of Force.—When a free needle has taken its position in the true line of the dip, it is held in that position by the *whole* force of the earth's magnetism; and this force, which may be determined by means of the dip and the horizontal force, is called the TOTAL INTENSITY OF FORCE.

Observations.—Now all these four quantities are found to vary, in passing, in certain directions, from one place to another, but there is usually some line along which each quantity is nearly the same. The lines, along which the variation is the same, are called lines of equal variation, as that from Lake Superior to North Carolina, along which the variation is nothing. Those lines along which the dip is equal, are called isoclinal lines, or lines of equal dip; as that on the chart, traced from the north-west corner of Illinois, through Indiana, the middle of Ohio, along the south part of Pennsylvania, through Philadelphia, to the Atlantic, marking the dip of 72°. Those lines, along which the total intensity is equal, are called isodynamic lines, or lines of equal force, as the several elliptical curves marked around Lake Superior, more or less parallel to each other. It will be seen that the development of these last lines has been the chief object of this paper.

A map of a country, with a delineation of these several lines, constitutes a magnetic chart of that country; a thing which cannot be made without much expense and labour, in the necessary experiments and calculations.

None of these quantities remain constant at the same place, but are undergoing a slow revolution; or, in other words, the several lines are gradually moving. Thus, the line of no variation, (and, with it, all lines of equal variation,) is gradually travelling westward. The city of Pittsburgh, Pennsylvania, which, a few years ago, had no variation, the line passing through it, has now a variation to the westward, the line of no variation being now found to the west of that city. The lines of equal dip have been said to be travelling slowly to the north, and the dip at any given locality to be, consequently, diminishing. Continued observations will determine this and other similar points.

Some Account of the Instruments, and of the Mode of Observation.

The following observations were made with instruments manufactured by the late Mr. Robinson of London. The dipping compass was furnished with two needles, each of six inches in length, and with the means of reversing their polarity. The results here tabulated, are, in each instance, the mean of sixteen readings, including all the usual

reversals. The hour of observing the dip is not put down in the tables, but it may in general be understood to have been about thirty minutes previous to the commencing of the observations for determining the intensity of force. The intensity apparatus was of the model invented by Professor Bache, by means of which Hanstenian needles are vibrated in a glass vessel nearly exhausted of air.

In almost every case these vibrations were commenced with an arc of about seven degrees on each side of the magnetical meridian, and continued to the number of five hundred, the arc then being between one and two degrees. The temperature was currently noted by means of an interior thermometer, and the duration of the vibrations reduced to the standard temperature of 60° Fahrenheit. The constant co-efficient for the effect of temperature on each needle, was determined by experiments in a room in the first place at the temperature of about 40°, and next in the same room artificially heated by a copper stove to near 90°. The result of these experiments was that the co-efficients for the several needles were as follows:

No. 1. .00012	No. 4. .000065
" 2. .000145	" 5. .000070
" 3. .000058	" 6. .000088

Needle No. 1, made by Robinson, was found to be somewhat inconstant in its magnetism, as will be seen by the observations recorded in the tables, some slight changes are also apparent by the results by No. 2, but Nos. 4, 5, and 6, made by myself, have proved themselves to be of superior quality. They were made of watch-makers' steel wire, and, were left at the highest degree of hardness which could be given to them by fire and water.

The chronometer used, made by Molyneux, was in all cases kept running so near to the mean rate that no equation was necessary except in the expedition to Lake Superior in 1843, when its daily rate was found to be fourteen seconds too fast. I regret that it was not always in my power to determine with more precision the magnetical declination, which I observed in but few instances, and then only by means of plumb-lines and naked sights, in the ordinary manner of the United States surveyors.

Explanation of the following Tables.—At the head of each is placed the date and the latitude and longitude of the place, either from the best observations, or from the most approved maps, Tanner's being, for the most part, preferred. In the Iowa and Wisconsin region, Judson's map was used, and, in the region of Lake Superior, Captain Bayfield's, as published by the Society for the Promotion of Useful Knowledge.

In the first column is placed the dip, as determined by the mean of sixteen observations; in the second, the number designating the intensity needle; in the third, the epoch of commencing the vibrations; in the fourth the observed duration of five hundred vibrations; in the fifth, the mean temperature, as indicated by an interior thermometer; in the sixth, the calculated duration at the standard temperature of 60°; in the seventh, the square of the number found in the sixth column; in the eighth, the horizontal intensity, that at Cincinnati, at some specified date, being reckoned 1000; in the ninth, the total intensity of force, in terms of the above named horizontal intensity at Cincinnati; in the tenth, the TOTAL INTENSITY OF FORCE, that at Cincinnati being recorded 1000. In the

course of these tables, rules are given by which these results may be reduced to the standard of unity adopted by Colonel Sabine, in his Report on Magnetism in 1838.

Correspondence.—After reducing my observations, in 1843, and putting them into the tabular form, I then compared them with the charts in Colonel Sabine's Report, above named, and was agreeably surprised at the coincidence of my actual observations with the chart lines which he had projected by means of surrounding observations, made so distant as the Atlantic, Baffin's Bay, and the Pacific. I immediately addressed letters to my friend Sears C. Walker, of Philadelphia, to the superintendent of the Magnetical Observatory, at Toronto, to the National Institute, at Washington, and to Colonel Sabine, R. A., at Woolwich, England, announcing briefly the result of my labours, and soliciting information as to what others had been accomplishing. Most of these letters were promptly responded to, and from Mr. Walker, Professor Bache, and Colonel Abert, I received valuable information, communicated in terms of great kindness. I have finally received a reply from Colonel Sabine, containing precisely the information which I desired, and encouraging me to further exertions in the same department of research, most obligingly offering me such assistance, in procuring instruments, as I might need. I quote, below, my own letter to the National Institute, as published by Colonel J. J. Abert, to whom it was addressed, and who, in conjunction with Mr. F. Markoe, communicated it to the National Intelligencer.

"*Medical College of Ohio, Cincinnati, October* 16, 1843.

"DEAR SIR:

"I ask the favour of you to announce to the National Institute, that, in my late tour to Lake Superior, I have discovered what is probably the place of maximum intensity of terrestrial magnetism. Major Sabine, in his Report to the British Association, in 1838, gives a chart of isodynamic lines in the northern hemisphere, on which he describes the line of intensity, 1.70, as an ellipsoid, extending, in latitude, from 35° to 69° north, and from Nova Scotia to the Pacific, almost, if not quite returning into itself at Behring's Straits; within this ellipsoid he has given a small portion of the line of 1.80, commencing at New York, and curving southward and westward to the Ohio River, and thence across the middle of Lake Erie. He suggests that this must be a closed curve, and adds, "as must also be that of 1.90, *supposing such to exist.*" This would suggest that, somewhere within this curve, there would be a point of maximum intensity, a kind of pole of greatest attraction, separate from the pole of greatest dip, and from that of the convergence of the magnetical meridians. Major Sabine observes, that "the intensities in Baffin's Bay and in the polar sea, have all a much lower value than at New York, and the general configuration of the line of intensity would rather point to a maximum in the vicinity of the shores of Hudson's Bay." These suggestions of Colonel Sabine are, in general, substantially supported by my observations, but the place of maximum intensity is much farther south than Hudson's Bay, being on Kewenan peninsula, on the south shore of Lake Superior. At this place, the intensity of one locality reached 1.97, and that of a mean of a group of observations, made in various neighbouring localities, was as high as 1.918. On the north side of the lake, at Isle Royal, it was found to be 1.908. I have just now completed the reduction of all my observations since 1838, and prepared them

for publication. They extend, geographically, from Cambridge, in Massachusetts, to Iowa territory, and from the middle of Kentucky to the north side of Lake Superior, including dip and intensity, and, in some places, declination also.

"Respectfully, Sir, your friend and obedient servant,

"JOHN LOCKE."

"To Colonel J. J. Abert."

A letter containing, substantially, the same information as the above, was, about the same time, addressed to Colonel Sabine, from whom, in due time, was received a prompt and obliging answer, from which the following is an extract.

"*Woolwich, (England,) November* 22, 1843.

"Dear Sir:

"I hasten to acknowledge the receipt of your very obliging and agreeable letter of the 25th of October. I am very glad to learn that the 'Report on Magnetism,' which I took the liberty of sending you in 1840, reached you in safety, and I cannot but be most highly gratified to hear that it in any degree contributed to induce you to undergo the labour and fatigue of making the series of magnetical observations over the extensive and important district of which you speak. I cannot doubt that so valuable a contribution to magnetical science, bearing so immediately on one of the critical points of magnetical theory, will be most warmly welcomed by one of your own national institutions, and will be published, as it is so desirable it should be, among the scientific records of the nation. Permit me to express the hope that, not less for the interests of science than for your own sake, you will spare no endeavour to obtain a very early publication of your observations. Both what they accomplish and what they leave unaccomplished will be a guide to those engaged in similar undertakings. The magnetic survey which is now in progress, under the direction of Lieutenant Lefroy, in British North America, is making a very rapid and successful advance, and promises to furnish ample materials for maps of the three magnetical elements north of the United States frontier. It is much to be desired that the survey should be met at the frontier by researches of citizens of the United States, conducted on their own grounds. I learn from your letter that you have yourself achieved already a very considerable part of this undertaking. The field of operation is thus greatly narrowed on the one hand, while, on the other, a full knowledge of the results which are obtained may be expected to indicate the direction in which further researches can be most profitably made. Lieutenant Lefroy informs me that in his journey from Toronto to York factory, on Hudson's Bay, pursued by the usual route of the Hudson's Bay Company boats, he found the magnetic force to increase until he arrived in the neighbourhood of Rainy Lake; at which spot it began to decrease, and continued to do so all the way to York factory. His observations would therefore seem to correspond in a remarkable degree with yours, in the indication of the locality of the maximum of intensity of the force; and we may infer that the principal axis of the inner isodynamic ovals crosses the meridians of 88° to 94° west, in the parallels of 47° to 48° north. For a more exact determination an examination on a north and south line, ascending the Mississippi to the point from whence the country can be most conveniently crossed

to the Red River, with the descent of the Red River to Lake Winnipeg,—and a transverse or east and west line, through the spot, or not very distant from it, where the highest intensity should be found in the north and south line, would appear extremely desirable; the east and west line to be pursued in both directions until the intensity of the force should be decidedly decreasing.

"Believe me, my dear Sir, with much respect, very sincerely yours,

"EDWARD SABINE."

I. SERIES, 1838, OHIO.

Cincinnati, Latitude 39° 06′; Longitude 84° 22′, W.; March 20, 1838.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°28′08″	1	2*h*.03*m*.05*s*.6 P	1544.00	89°00	1538.63	2367382.2769	1000		
	2				1513.76	2291469.3376	1000		
	3				1235.60	1525225.0000	1000		
						Mean,	1000	2991.1	1000.

Remarks.—Needle No. 1. The mean time or duration for five hundred vibrations at the temperature of 60° deduced from ten series, of five hundred vibrations each, made March 10, is equal to 1540.20.

Needle No. 2. The mean time or duration of five hundred vibrations, at the temperature of 60°, deduced from five series, of five hundred vibrations each, made March 10 to 11, is equal to 1513.76.

Needle No. 3. The duration of five hundred vibrations at the temperature of 60°, deduced from ten series, of five hundred vibrations each, made January 17 to 20, equal to 1235.60.

Locality. Longworth's garden. Substratum, diluvial loam and gravel based on the horizontally stratified blue limestone of the silurian formation.

Dayton, Latitude 39° 44′, N.; Longitude 84° 17′, W.; March 26, 1838.

1°22′42″	1	3*h*.00*m*.00*s*.6 P	1572.80	73°00	1570.35					
	1	2 55 04 0*	1578.	85 30	1573.27					
				Mean,	1571.81	2470555.24	958.25			
	2	6 30 04 5 A	1544.40	53 00	1546.00					
	2	8 24 01 6	1548.00	60 75	1548.00					
				Mean,	1547.00	2393209.00	957.20			
	3	7 14 04 4	1260.00	55 6	1260.32					
	3	9 13 01 2	1262.00	67 5	1261.45					
				Mean,	1260.88	1589868.81	959.20			
		* March 27.				Mean,	958.20	3001.0	1003.2	

Geology. Alluvium underlaid by horizontally stratified blue limestone.

Springfield, Ohio, Latitude 39° 54′; Longitude 83° 51′; March 29, 1838.

71°27′23″	1	9*h*.58*m*.02*s*.4 A	1580.00	67° 50	1578.58	2491914.8164	950.02		
	2	11 17 05 2	1557.80	71 00	1554.72	2417154.2784	948.00		
	3	12 33 02 0	1268.00	72 00	1267.72	1607113.9984	949.04		
						Mean,	949.02	2984.3	997.8

Substratum, cliff limestone in horizontal strata. Place, ½ mile north of the village.

Urbana, Ohio, Latitude 40° 05′; Longitude, 83° 48′; March 3, 1838.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
71°39′45″	1	4*h*.34*m*.02*s*. P	1577.6	63°5	1577.00	2486929.00	951.93		
	2	5 18 02 0	1552.8	60 0	1552.80	2411187.84	954.53		
March 31,	3	10 21 04 6 A	1265.4	70 0	1264.87	1599896.12	953.32		
						Mean,	953.26	3027.9	1012.2

Cliff limestone deeply covered with diluvial gravel.

Columbus, Ohio, Latitude 39° 57′, N.; Longitude 83° 02′, W.; April 2, 1838.

71°04′52″	1	11*h*.00*m*.05*s*.6 A	1559.6	49°	1561.60	2438594.56	966.69		
	2	11 41 00 8	1538.8	50	1541.00	2374681.00	964.95		
	3	12 39 04 4	1254.0	51	1254.65	1574146.6225	968.28		
						Mean,	966.64	2981.3	996.72

Geology, cliff limestone.

II. SERIES, 1839, IOWA, WISCONSIN, &c.

2. St. Louis, Latitude 38° 36′, N.; Longitude 90° 15′, W.; September 6, 1839.

69°31′26″	1	1*h*.02*m*.00*s*. P	1514.4	84°5	1509.95	2279949.0025	1038.40		
	2	1 42 00	1490.4	87 5	1484.46	2203621.4916	1048.18		
	3	2 18 04 4	1211.9	87 0	1210.00	1464100.	1042.32		
						Mean,	1042.97*	2981.50	997.35†

Locality. Mrs. Asherly's garden, near the reservoir, and the ancient mound-works.
Geology. Horizontal carboniferous limestone.

3. Davenport, Iowa, Latitude 41° 30′, N.; Longitude 90° 34′, W.; September 13, 1839.

71° 55′	1	3*h*.01*m*.01*s*.2 P	1591.6	70°5	1588.74	2524094.7876	937.98		
	2	4 00 59 2	1568.8	69 5	1566.64	2454360.8896	941.91		
	3	4 49 02 8	1274.8	67	1274.28	1623789.5184	939.82		
						Mean,	939.90	3028.03	1012.91

Declination 7° 50′, east, (surveyors.) Locality,—at the foot of the hill north of town; carboniferous limestone.

4. Davenport again, on the hills north of Shoemaker's Spring; Latitude 41° 30′; Longitude 90° 36′.

71°55′15″	1	3*h*.03*m*.03*s*.2 P	1593.6	76°	1590.3	2529044.90	936.12		
	2	3 43 04 4	1571.6	75	1568.2	2459251.24	939.32		
	3	4 43 59 6	1276.4	75	1275.3	1626390.09	938.32		
						Mean,	937.92	3021.32	1011.00

5. Lost Grove, (Iowa,) Latitude 41° 39′, N.; Longitude 90° 25′, W.; September 23, 1839.

72°02′26″	3	2*h*.45*m*.03*s*.6	1278.	75°	1276.9	1630473.61	935.96	3028.46	1015.39

Locality and geology. Near the point where the cliff limestone, coming up, with a gradual dip from the south, emerges from underneath the carboniferous limestone, to occupy the surface northwardly, nearly to Prairie du Chien.

* Horizontal intensity at Cincinnati, August 18, 1840, being 1000.
† Total intensity at Cincinnati, August 18, 1840, being 1000.

6. Wapsipinnicon River, (Iowa,) Latitude 41° 44′, N.; Longitude, 90° 39′, W.; September 25, 1839.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 15′	1	9*h*.04*m*.59*s*.6	1596.	56°	1596.77	2549674.4329	928.54		
	2	9 59 00 4	1574.4	56 5	1575.02	2481255.0400	930.89		
	3	11 12 03 2	1280.4	61 7	1280.27	1639091.2729	931.04		
						Mean,	930.16	3051.06	1020.61

Declination, 8° 25′, east. Observed by myself.

Locality: on the rocky table or upper bank of the river, which was in a channel moderately deep. Geology: cliff limestone cropping out at bluff banks, but covered generally with good soil, prairie and scattered timber. Wind from north-west, blowing by gusts, a moderate gale; clouds ragged cumulo-stratus, covering half of the sky, each occupying 10 to 30 degrees. Sky beautifully blue and clear between.

7. Iron ore bed, (Iowa,) Latitude 41° 55′, N.; Longitude 90° 56′, W.; September 27, 1839.

72°50′30″	3	8*h*.51*m*.03*s*.2 A	1295.2	49°	2960.4	1679719.6816	908.52	3079.59	1030.16

Declination, 7° 05′, east, (Locke.)

Locality, about three quarters of a mile from the Wapsipinnicon river. Surface rather uneven. The iron ore in place appeared to be the hydrated peroxide, often hematitic, not at all magnetic, but some loose pieces, probably transported, were not only magnetic, but actually possessed polarity. The magnetism of this place, it appears, is peculiar, the dip and intensity being both greater than the latitude elsewhere exhibits.

8. Mill at Brown's Settlement, Latitude 42° 02′, N.; Longitude 91° 18′, W.; September 30, 1839.

72° 21′	1	11*h*.10*m*.04*s*.0 A	1603.6	53°	1605.	2576025.	919.05		
	2	11 54 00 4 A	1586.0	55 5	1587.03	2518664.2209	917.07		
	3	12 40 02 0 P	1289.0	57 6	1289.18	1661985.0724	918.22		
						Mean,	918.11	3028.05	1012.92

Declination, 9° 10′, east, (surveyors;) 9° 04′, by my own observation. Locality, in a valley.

9. Branch of the Makoqueta River, Latitude 42° 14′, N.; Longitude 91° 09′, W.; October 2, 1839.

72°43′37″	3	9*h*.40*m*.02*s*.0 A	1300.	64°	1299.7	1689220.09	903.41	3042.57	1017.77

Declination, 8° 45′, east, (by surveyors.)

Locality, near a bluff or cliff limestone thirty feet high. Weather clear and fine; a few cirrus clouds.

10. Farmers' Creek, (Iowa,) Latitude 42° 13′, N.; Longitude 90° 39′, W.; October 5, 1839.

72° 36′	1	12*h*.43*m*.01*s*.2 P	1613.2	76°	1610.1	2592422.01	913.24		
	2	1 21 01 6 P	1594.	83 28	1588.7	2522867.69	915.54		
	3	3 52 00 8 P	1292.4	66	1291.95	1669134.8025	914.29		
						Mean,	914.36	3057.64	1022.82

Declination, 9° 11′, east, by my own observation, and 9° 4′, by United States surveyors. High tables of cliff limestone cut deeply, and abruptly, by the streams, characterize

this neighbourhood. The experiments were made on the margin of the creek, under the shadow of a shelving rock, which, being about nine feet high, served to screen the apparatus from the sun. The table land undulating, fertile, grassy prairie.

11. White Water, (Iowa,) Latitude 42° 18′, N.; Longitude 90° 51′, W.; October 18, 1839..

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 55′	3	11*h*.04*m*.00*s*.4	1308.8	77°5	1307.47	1709477.8009	892.70	3038.85	1016.53

Declination, 9° 10′, east, (surveyors.)
Locality, in the sandy channel of a dried up brook, beside a limestone bluff.

12. North Branch of Makoqueta, Latitude 42° 23′, N.; Longitude 91° 09′, W.; October 9, 1839.

72° 51′	3	11*h*.59*m*.59*s*.6 A	13096.	59°	1309.67	1715235.5089	889.71	3017.25	1009.31

Declination, 9° 35′, east, (surveyors.)
Cloudy and interruptedly rainy, with gusts of wind from the south. Observations made inside of the tent. Dipping needle fluctuating, as if by an aurora or a "magnetical storm."

13. Dubuque, (Iowa,) Latitude 42° 29′, N.; Longitude 90° 39′, W.; October 14, 1839.

73° 05′	3	12*h*.51*m*.03*s*.6 P	1316.	54°	1316.46	1733066.9316	880.55	3028.66	1013.00

Declination, 8° 22′, east, (surveyors.)
At Dubuque's grave, one mile distant from this locality, the dip is 73° 05′ 45″. The dip and intensity, as first given, were taken in the bottom of Dougherty's Lead mine, one hundred feet deep; both the dip and intensity appeared to be the same as at Dubuque's grave, a locality about a mile distant, and immediately on the river bank. The lead mine is a vertical fissure in the limestone, from three to twelve feet wide, running from east to west, and but partially worked out. It would not seem, then, that these veins of Galena exert any sensible influence on the magnetic elements.

14. Forks of Little Makoqueta, (Iowa,) Latitude 42° 31′, N.; Longitude 90° 47′, W.; October 20, 1839.

73° 08′	1	6*h*.15*m*.04*s*. A	1634.	34°	1639.4	2687632.36	880.88		
	2	7 02 04 4	1612.	36	1616.16	2611973.1456	884.31		
	3	8 16 00 4	1317.	51 3	1317.86	1736754.9796	878.61		
						Mean,	881.27	3037.34	1016.02

Declination, 8° 30′, east, (surveyors.)
Clear, brisk north wind. Experiments made inside of the tent, all iron being removed. Locality, the diluvial bottom of a small stream, having perpendicular bluffs of horizontal cliff limestone, two hundred feet high, on each side, and distant, say four hundred yards.

15. Turkey River, (Iowa,) Latitude 42° 42′, N.; Longitude 91° 05′, W.; October 22, 1839.

73° 11′	3	10*h*.11*m*.04*s*.8	1322.4	65°	1322.	1747684.	873.19	3018.18	1009.61

Declination, 9° 00′, east, (surveyors.)

Locality, on the alluvion of the river, near a town called Winchester. High cliff limestone bluffs at a moderate distance from the valley of the stream. Cloudy, smoky, calm. Barometer 749.4 mill.; thermometer 16. cent.

16. Prairie du Chien, W. T., Latitude 43° 01′, N.; Longitude 91° 08′, W.; October 24, 1839.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73°16′35″	3	11*h*.28*m*.02*s*.4	1320.	65°	1319.62	1741396.9444	876.34	3045.44	1018.73

Declination, 9° 5′, east, (surveyors.)

Although noted at Prairie du Chien, the experiments were made at the ferry, on the side of the Mississippi opposite the prairie, on a low alluvion, surrounded very closely by precipitous bluffs of sandstone and limestone, geologically lower than the cliff, and scarcely fossiliferous, but still horizontally stratified.

17. Blue Mound, W. T., Latitude 43° 01′, N.; Longitude 89° 54′, W.; October 29, 1839.

73° 41′	3	1*h*.55*m*.03*s*.2 P	1335.6	46°	1336.7	1786766.89	854.00	3038.54	1017.43

Declination, 8° 38′, east, (surveyors.)

The above locality is in the bed of a streamlet west of the West Mound. The Blue Mounds are conical outliers of the cliff limestone, three hundred feet of their upper part being silicious chest, horizontally stratified. The base contains lead ore. They rest on sandstone, and are one thousand feet above the Wisconsin river.

18. Madison, W. T., Latitude 43° 05′, N.; Longitude 89° 41′, W.; November 2, 1839.

74°03′30″	1	10*h*.20*m*.00*s*.4	1666.8	54°1	1667.2	2779555.84	851.79		
	2	9 15 03 2	1643.2	45	1647.17	2713169.0089	851.32		
	3	8 39 00 0	1336.4	44 5	1337.5	1788906.25	852.06		
						Mean,	851.72	3102.25	1037.76

Declination, 7° 30′, east, (surveyors.)

Locality, near the capitol, say four hundred yards from it. The rocks are limestone, horizontally stratified, but scarcely fossiliferous. No height around much above the site of the observations.

19. Mineral Point, W. T., Latitude 42° 50′, N.; Longitude 90° 10′, W.; November 5, 1839.

73°20′37′	1	12*h*.07*m*.03*s*.2	1646.8	43°	1650.15	2722995.0225	869.45		
	2	12 46 01 6	1627.6	44	1631.37	2661368.0769	867.89		
	3	11 36 00 4	1324.4	44	1325.63	1757294.8969	868.47		
						Mean,	868.60	3030.40	1013.70

Declination, 8° 40′, east, (surveyors.)

Locality, a moderately deep valley, one mile east of town, with no bluffs or peculiar elevation near. Geology, cliff limestone, horizontally stratified, and containing lead ore, and some copper in the underlying rock.

At 6*h*. A.M. Barometer 720.0 millimeters; thermometer 6. cent. Wind north.

20. Cincinnati, Latitude 39° 06′, N.; Longitude, 84° 22′, W.; September 24, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°29′11″	1	11*h*.19*m*.00*s*.6	1542.8	66°4	1541.6	2377147.24	995.94		
	2	12 00 03 8	1524.6	70	1522.4	2317701.76	996.58		
	3	12 39 01 2	1237.2	70	1236.48	1528932.25	998.12		
						Mean,	996.88	2984.40	998.31

III. SERIES, 1840, OHIO, KENTUCKY, AND INDIANA.

21. Cincinnati, August 18, 1840, Latitude 39° 06′, N.; Longitude 84° 22′, W.

70°27′26″	1	11*h*.09*m*.01*s*.2 A	1542.	78°	1538.67	2367505.3689			
	2	12 13 01 6 P	1524.	78 75	1519.8	2309792.04			
	3	1 06 01 6	1235.34	78 5	1235.34	1526064.9156			
						Mean,	1000	2989.4	1000.

Done at the most usual locality for Cincinnati—Mr. Longworth's garden, under the bank descending towards Deer Creek. Coefficients for the several needles as follows, namely, No. 1, 00012.; No. 2, 000145.; No. 3, 000058.

22. Hamilton, Ohio, Latitude 39° 23′, N.; Longitude 84° 32′, W.; August 20, 1840.

70° 58′	1	10*h*.42*m*.02*s*. A	1560.8	80°	1557.05	2424404.70	976.55		
	2	11 18 03 6	1540.4	85	1535.0	2356225.	980.24		
	3	11 57 01 4	1250.6	82	1249.0	1560001.	978.02		
						Mean,	978.33	2999.9	1003.50

23. Dayton, Ohio, Latitude 39° 44′, N.; Longitude 84° 17′, W.; August 21, 1840.

71° 22′	1	2*h*.14*m*.00*s*.0 P	1578.8	83°5	1574.34	2478546.4356	9511.		
	2	2 53 02 2	1561.4	84 0	1555.77	2420420.2929	9543.		
	3	3 27 00 0	1264.	84 0	1262.24	1593249.8176	9577.		
						Mean,	9544.0	298.71	999.15

Locality, the broad alluvion of Dayton, underlaid with gravel. Rocks in situ, the blue horizontal limestone, the same as at Cincinnati. Meteorology, clear with a mixture of cirri and cumuli. Some distant thunder, but no rain. Wind south-east, gentle. Evening clear, with some meteors.

24. Piqua, Ohio, Latitude 40° 06′, N.; Longitude 84° 13′ 5″, W.; August 22, 1840.

71°35′50″	1	4*h*.41*m*.00*s*.8 P	1585.2	80°	1581.4	2500825.96	946.60		
	2	5 26 59 6	1568.0	79	1563.7	2445157.69	944.60		
	3	6 06 00 0	1270.0	70	1269.26	1602094.76	947.20		
						Mean,	946.10	2997.3	1002.60

Geology, horizontal cliff limestone, country level.

25. Lebanon, Ohio, Latitude 39° 26′, N.; Longitude 84° 06′, W.; August 24, 1840.

71°02′45″	1	4*h*.53*m*.00*s*.4 P	1563.2	77°5	1560.	2433600.	972.84		
	2	5 34 00 8	1545.6	75 5	1542.13	2378164.9369	971.25		
						Mean,	972.04	2993.63	1001.07

Horizontally stratified blue limestone, near the surface.

26. Mason, Ohio, Latitude 39° 22′, N.; Longitude, 84° 13′, W.; August 25, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°54′12″	1	9*h*.30*m*.00*s*. A	1557.6	75°	1554.8	2417403.04	979.35		
	2	10 11 02 8	1543.2	77	1539.4	2369752.36	974.69		
	3	10 51 04 4	1251.2	78	1249.9	1562250.01	976.83		
						Mean,	976.90	2986.16	998.90

Calm, cloudless, fine. Locality, in the woods, on the level surface of the blue limestone.

27. Cincinnati, August 26, 1840.

70°27′54″	1	11*h*.4 *m*.59*s*.6 A	1542.8	74°4	1540.14	2372011.2196	998.10		
	2	11 40 04 8	1526.8	75 5	1523.37	2320656.1569	995.32		
	3	12 16 01 2	1238.0	76 5	1236.82	1529723.7124	997.67		
						Mean,	997.03	2981.74	997.43

Calm, sun shining, but through a hazy cloud.

It appears above, that although the total intensity at Mason, August 25, was less than the same at Cincinnati, August 18, yet it was greater than at the same place on the 26th. As this experiment was made on the day *succeeding* that at Mason, it may be taken as the nearest correct comparison.

28. Williamstown, Kentucky, Latitude 38° 36′, N.; Longitude 84° 22′, W.; September 1, 1840.

70°04′07″	1	10*h*.32*m*.59*s*.2 A	1532.4	77°	1529.27	2338666.7329	1012.3		
	2	11 23 13 2	1514.8	77	1511.07	2283332.5449	1011.1		
	3	12 06 01 4 P	1228.6	79	1227.25	1506142.5625	1013.2		
						Mean,	1012.2	2969.27	993.25

Locality, about half a mile east of Williamstown, on a ridge bordering a ravine. Rocks, blue fossiliferous limestone, underlying the soil. The greatest eastern elongation of polaris had for its azimuth 2° 57′, west of magnetic north. The variation or declination was then about 4° 57′, east. This was ascertained by the usual method adopted by surveyors, by means of plumb lines.

29. Lexington, Kentucky, Latitude 38° 06′, N.; Longitude 84° 18′, W.; September 2, 1840.

69°54′30″	1	4*h*.17*m*.10*s*.4 P	1531.2	74°	1528.63	2336709.6769	1013.22		
	2	4 54 02 4	1514.4	73	1511.56	2284813.6336	1010.93		
	3	5 30 00	1228.8	71	1228.09	1508205.0481	1011.84		
						Mean,	1012.00	2945.94	985.42

Weather cloudy. Locality, Richard Higgins's garden. Substratum, horizontal limestone, covered by a soil about nine feet deep. This is probably identical with the limestone of Cincinnati, but is more massive, containing less clay marl, which abounds at Cincinnati, interstratified with the thin layers of stone.

30. Clay's Ferry, Latitude 37° 54′, N.; Longitude 84° 18′, W.; September 3, 1840.

69° 49′	1	12*h*.20*m*.05*s*.2 P	1526.	75° 5	1523.25	2320290.5625	1020.35	2957.32	989.27

On the bank of the Kentucky river. Substratum limestone, the same as at Lexington. A bluff limestone bank within one-third of a mile.

31. Frankfort, Kentucky, Latitude 38° 14′, N.; Longitude, 84° 40′, W.; September 4, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
69°54′53″	1	11*h*.56*m*.00*s*.8 A	1528.8	73°5	1526.23	2329378.0129	1016.36		
	2	12 30 58 8 P	1511.6	73 0	1508.75	2276326.5625	1014.70		
	3	1 05 00 6	1227.6	72 5	1226.71	1504817.0741	1014.12		
						Mean,	1015.06	2954.76	988.76

Wind from the north; somewhat cloudy. Locality, half a mile east of the capitol, and on the south side of a ravine or ancient river bed, close to a precipitous limestone bluff.

32. Louisville, Kentucky, Latitude 38° 03′, N.; Longitude 85° 30′, W.; March 11, 1840.

69°54′26″	1	11*h*.40*m*.02*s*.4 A	1518.	39°5	1521.73	2315662.1929	1022.38		
	2	12 14 04 0 P	1498.4	41	1502.52	2257566.3504	1023.13		
	3	12 48 03 2	1219.2	43	1220.4	1489376.16	1024.63		
						Mean,	1023.38	2978.90	996.48

The close coincidence of horizontal intensities, at temperatures so different, is good evidence that the coefficients for temperatures have been correctly deduced. Locality, Jacobs' woods, a mile or more south-east of the court house; surface, level substratum cliff limestone. At Corn Island, in the falls of the Ohio, not two miles distant, the dip, by observations, September 7, 1840, was eight minutes more than at this locality. The same thing appeared in 1839.

33. Vernon, Indiana, Latitude 37° 59′, N.; Longitude 87° 47′, W.; September 10, 1840.

68°56′17″	1	11*h*.30*m*.02*s*.4 A	1493.2	75°5	1490.42	2221351.7764	1065.79		
	2	12 14 02 8 P	1477.2	76	1473.77	2171998.0129	1063.44		
						Mean,	1064.61	2964.51	991.33

Clear, wind gentle. Locality, a dense wood on the "bottom land," or river alluvium, five hundred yards east of the town-landing. Substratum, the horizontal sandstone of the coal formation.

34. New Harmony, Indiana, Latitude 38° 11′, N.; Longitude 87° 48′, W.; September 11, 1840.

69°03′37″	1	3*h*.00*m*.02*s*.0 P	1496.8	70°	1495.00	2235025.	1059.27		
	2	3 35 01 2	1480.0	69 5	1478.85	2186997.3225	1056.15		
	3	4 10 03 6	1201.2	70 0	1200.50	1441200.25	1058.88		
						Mean,	1058.10	2961.80	990.76

Cloudy. Locality, on the bank of the Wabash river, at what is called the "cut off," three-fourths of a mile south-west of the town. Substratum, sandstone of the coal measure.

35. Princeton, Indiana, Latitude 38° 23′, N.; Longitude 87° 30′, W.; September 16, 1840.

69°22′48″	1	9*h*.45*m*.59*s*.2 A	1507.6	75°5	1504.8	2264423.04	1045.52		
	2	10 20 01 6	1491.2	78 0	1487.3	2212061.29	1044.18		
	3	11 11 00 0	1209.6	79 25	1208.25	1459868.0625	1045.34		
						Mean,	1044.68	2966.40	992.29

Locality, one-third of a mile north of the court house, in a thick wood of small timber, soil, clay and level, evidently wet in the spring season. Geology, horizontal sandstone of the coal measures. Wind southwardly, signs of approaching rain.

36. Vincennes, Indiana, Latitude 38° 43′, N.; Longitude 87° 25′, W.; September 18, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
69°51′10″	1	10*h*.12*m*.02*s*.4 A	1517.6	58° 5	1517.86	2303929.3369	1027.56		
	2	11 06 03 6	1502.0	60 5	1501.9	2255703.61	1024.25		
	3	11 46 04	1219.6	62 5	1219.42	1486985.1364	1026.28		
						Mean,	1026.03	2978.89	998.54

Clear, calm, wind westward. Locality, bank of the Wabash river, one and one-fourth miles above Vincennes. Soil, alluvial substratum sandstone, of the Illinois coal basin.

37. Paoli, Indiana, Latitude 38° 35′, N.; Longitude 86° 25′, W.; September 20, 1840.

69°33′47″	1	10*h*.05*m*.00*s*.4 A	1517.2	71°	1515.2	2295831.04	1031.22		
	2	10 44 00	1499.6	73	1496.77	2240320.4329	1031.01		
	3	11 31 58 4	1216.4	76	1215.27	1476881.1729	1033.30		
						Mean,	1031.84	2953.68	988.04

One-fourth of a mile north-east of the court house, on a side hill. Substratum, compact horizontal limestone, (the carboniferous.) Clear, calm, very fine; wind north-west.

38. Cincinnati, September 24, 1840.

70°29′11″	1	11*h*.19*m*.00*s*.6 A	1542.8	66° 4	1541.8	2377147.24	995.94		
	2	12 00 03 8 P	1524.6	70	1522.4	2317701.76	996.58		
	3	12 39 01 2	1237.2	70	1236.5	1528932.25	998.12		
						Mean,	996.88	2984.40	998.31

Latitude and locality as before described.

IV. SERIES, 1841, CINCINNATI TO NEW YORK.

39. Total intensity at Cincinnati, May 8, 1841, compared with that at the same place, August 18, 1841, the last being reckoned unity.

70°26′11″	1	11*h*.44*m*.00*s*.4	1539.6	59° 17	1539.62	2370368.16			
	2	12 17 00 4	1520.	61 4	1519.69	2309457.6961	1000.01		
	3	12 47 03 6	1236.	62	1235.86	1527349.9396	999.16		
	4	1 12 02 8	1110.4	62	1110.26	1232677.2676			
	5	1 36 00 8	1350.8	63	1350.52	1823904.2704			
	6	2 03 01 2	1347.2	63	1346.84	1813977.9866			
		Mean of the horizontal intensity by the needles Nos. 2 and 3,					999.58	2983.88	998.56

After obtaining the horizontal intensities, as above, by dividing the squares of the duration of five hundred vibrations at any place into similar squares at the place assumed as the standard of unity, the reductions for total intensity were effected by the following formulæ, always using Hassler's logarithmic and trigonometric tables, as published in New York, in 1830.

As cos. 70°26′11″		9.5248544,	Magnetic dip at Cincinnati, May 8, 1841.
Is to R.		10.	Logarithmic radius.
So is	9.9956	0.9998176	Hor. Int. at Cincinnati, May 8, that at the same place Aug. 18, 1840, being 10.
To	29.8513	1.4749632*	Total intensity, May 8, horizontal intensity, August 18, 1840, being 10.

* 1.4751456, Log. of total intensity, horizontal being unity.

And as	29.8940	1.4755891	Total intensity, August 18, 1840, horizontal being 10.
To	29.8513	1.4749632	Total intensity, May 8, &c.
So is	10.	1.	Horizontal intensity at Cincinnati, August 18, 1840, assumed as unity.
To	99.856	0.9993741	Total intensity, May 8, that on August 18, 1840, being 10.

Thus it appears that the magnetical intensity at Cincinnati, May 8th, 1841, was extremely near that at the same place in August 18, 1840, which has been used as the unit or standard of comparison for the Iowa and Wiskonsin observations, made in 1839, the difference being only 1.44 parts in 1000. It appears, by applying the equation $C = \frac{RH}{T}$, in which C = cosine of dip, R = radius, H = horizontal, and T = total intensity, that an increase of 1′45″ of the estimated dip would complete the equality.

If it be asked why I have not included more than two needles in obtaining the above mean result of the horizontal intensity, I answer, that No. 1, since being used, August 18, 1840, had been connected, by iron keepers, with No. 2, and had evidently changed its magnetism. Nos. 4, 5, and 6, had not been used in August, and, indeed, were for the first time used in this series.

Having made and explained the above comparisons, I shall proceed to use the squares of the times of five hundred vibrations of each of the six needles, as given above, for May 8th, 1841, as quotients or standards of comparison, for obtaining the values of intensities, as observed at other times and places referred to in the above, as unity. I had intended to have used the results obtained at Philadelphia as the standard of unity; but I have found it more convenient to refer all my observations to a locality to which I could have more frequent access, and at which I could, from time to time, observe the secular changes and anomalous fluctuations of the magnetical elements. I am rather surprised to find the total intensity at Cincinnati not only near to that at Philadelphia, but a little above it.

40. Total intensity at Cincinnati, May 8, 1841, horizontal intensity, at the same time and place, being 1, 10, or 1000.

As cos. 70° 26′ 11″		9.5248544	
To R.		10.	
So is	10	1.	Assumed horizontal intensity at Cincinnati.
To	29.8638	1.4751456	Total intensity at Cincinnati, May 8, 1841.

41. Philadelphia, Latitude 39° 57′, N.; Longitude 75° 10′, W.; March 30, 1841.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°00′10″	1	1*h*.29*m*.01*s*.2	1604.	43°	1607.27	2583316.8529	917.57		
	2	2 06 01 2	1582.	44 2	1585.62	2514190.7844	918.57		
	3	2 40 03 6	1290.4	50	1291.15	1667068.3225	916.19		
	4	4 04 02 4	1156.8	44 5	1157.99	1340940.8401	919.26		
	5	4 33 00	1408.8	44	1409.98	1988043.6104	917.43		
	6	5 08 04 8	1403.6	43	1405.7	1975992.49	918.01		
						Mean,	917.84	2970.80	994.783

Particular locality, in the yard of the Magnetical Observatory, near the Girard College. Geology, probably primitive rocks, covered by many feet of gravel and drifted materials.

42. Philadelphia, March 31, 1841.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°01′20″	1	12*h*.32*m*.00*s*.8	1605.6	51°	1607.34	2583541.8756	917.11		
	2	1 22 04 4	1585.2	50 5	1587.38	2519775.1644	916.53		
	3	1 57 00	1290.5	51	1291.17	1667119.9689	916.12		
	4	2 52 02 8	1158.	51 5	1158.75	1342001.5625	918.53		
	5	3 22 59 6	1410.	50	1410.84	1990469.5056	916.53		
	6	3 55 02 8	1404.8	51 5	1405.85	1976414.2225	917.86		
						Mean,	917.11	2971.38	994.975

One hundred and fifty feet north-east of the Magnetical Observatory. Locality, same as before.

43. Pittsburgh, Pa., Latitude 40° 32′, N.; Longitude 80° 02′, W.; March 22, 1841.

72°43′30″	1	11*h*.00*m*.02*s*.8	1632.2	68°	1630.63	2658954.1969	891.47	3002.00	1005.23

Locality, "Hogs-back," three hundred feet, west of Theological Seminary, in Allegheny-town. Geology, sandstone of the coal measures.

44. Philadelphia, April 26, 1841.

71° 59′	1	1*h*.30*m*.03*s*.2	1609.6	70°	1607.67	2584602.8289	917.11		
	2	2 11 02 8	1587.2	65 5	1585.95	2515237.4025	918.20		
	3	2 45 00 4	1291.6	67 5	1290.84	1666267.9056	916.63		
	4	3 16 03 2	1159.2	70	1158.45	1342006.4025	918.53		
	5	3 52 59 6	1412.	71 8	1410.83	1990441.2889	916.34		
	6	4 25 03 2	1406.	67 4	1405.89	1976526.6921	917.76		
						Mean,	917.43	2965.21	993.245

At twelve hours thirty-seven minutes. Cloudy, calm; clouds becoming thinner.

45. Trenton, N. J., Latitude 40° 13½′, N.; Longitude 74° 40′, W.; April 23, 1841.

71° 59′	4	1*h*.47*m*.58*s*.8	1156.	57°	1156.22	1336844.6884	922.08		
	5	2 16 03 2	1406.8	54 4	1407.35	1980634.0225	920.86		
	6	2 51 00 4	1402.	54	1402.75	1967707.5625	921.87		
						Mean,	921.60	2979.60	997.76

Soil alluvial, with a primitive substratum. Air damp and misty. Place, a woodland about three-fourths of a mile north of Trenton, near a streamlet, and just below a deserted turnpike road. Time noted by New York meridian.

46. Newark, New Jersey, Latitude 40° 43′, N; Longitude 74° 10′, W.; April 19, 1841.

72° 49′	1	10*h*.1 *m*.00*s*.4 A	1640.8	49°	1642.96	2699333.9912	878.13		
	2	10 42 01 6	1620.4	50 5	1622.63	2632928.1169	877.11		
	3	11 11 00 4	1320.	51	1320.68	1744195.6624	872.46		
	4	8 19 03 2	1182.	45 5	1183.11	1399749.2721	880.64		
	5	8 49 02 8	1439.6	45	1441.11	2076798.0341	878.13		
	6	9 24 04 4	1435.6	47 5	1437.17	2065486.3524	878.23		
						Mean,	878.45	2974.46	995.673

Time, by the meridian of Philadelphia.

Locality, "down the neck," in Morris's woods, so thick as to exclude the wind, which, with a clear sky, blew in strong gusts. Geology, probably sand underlaid

with sandstone in place, but with trap-rocks near. The above experiments were made on the eighteenth and nineteenth, and both the dip and horizontal intensity varied considerably. The last, as indicated by Nos. 4, 5, and 6, on the eighteenth, would be 879.00; and, by Nos. 1, 2, and 3, on the nineteenth, would be 876.23; a difference which corresponds to a change of dip equal to 3′ 37″. The dip observed on the eighteenth was 72° 52′, and that on the nineteenth, 72° 46′ which is a range of difference greater than that indicated by horizontal intensity, by 2′ 23″. It will be seen that I have taken the mean both of dip and intensity; but, by this note, I have put the reader in possession of all the facts. Still, I am not satisfied with the results at this locality. Will the stationary observers refer to their records for this time?

47. New York, Columbia College, April 19, 1841; Latitude 40° 43′, N.; Longitude 74° 01′, W.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 41′	1	4*h*.19*m*.59*s*.6 P	1643.2	55°	1644.18	2703327.8724	876.83		
	2	4 55 00 4	1614.4	54	1615.8	2610809.64	884.57		
	3	5 27 04 8	1315.2	55	1315.58	1730750.7364	882.47		
						Mean,	883.52	2969.20	994.282

Locality, the yard of the college, near the usual place of observation, which was pointed out to me by Professor Renwick. But, an iron fence having been erected on the outer side of the yard, it became necessary to remove to a place about central between that fence and the college building. Geology, deep diluvium, underlaid by gneiss rocks?

48. Near Harlaem, eight miles north-east of New York, April 20, 1841.

72° 21′	1	11*h*.44*m*.04*s*. A	1622.4	58° 1	1622.65	2632993.0225	900.26	2969.18	994.239.

Locality, about three hundred feet south-west of the new asylum for the insane, situated about one mile from Harlaem. Geology, gneiss rock, covered with soil, and an abundance of trappean bowlders, of large size. The dip was so extraordinary that, after vibrating one needle, I removed less than a mile, to the old asylum.

49. Old Asylum, near Harlaem, April 20, 1841.

72°39′36″	1	2*h*.09*m*.02*s*.8*	1635.2	57° 2	1635.78	2675776.2084	885.86		
	2	3 51 00	1618.4	54	1619.81	2623784.4361	880.20		
	3	2 48 03 6	1317.6	56	1317.09	1736860.41	879.37		
	4	3 20 59 2	1175.6	56	1175.9	1382740.81	891.47		
	5	4 21 59 6	1439.2	54	1439.8	2073024.04	879.83		
	6	4 50 00 8	1434.54	52 6	1435.47	2060574.1209	880.33		
						Mean,	882.84	2961.90	991.800

Locality, in a grove north-east of the old asylum. Geology, as above. Cloudy, wind south-east, sun-veiled, occasionally a little mist of fine rain.

50. Baltimore, Howard's Woods, April 28, 1841; Latitude 39° 17′, N.; Longitude 76° 37′, W.

71°34′06″	1	8*h*.18*m*.02*s*.	1589.2	54°	1590.34	2529181.3156	937.20		
	2	8 58 04	1569.6	54	1570.95	2467883.9025	935.80		
	3	10 05 03 6	1276.8	57 5	1277.	1630729.	936.60		
	4	10 40 00 8	1146.8	65 5	1146.64	1314783.2896	937.55		
	5	11 07 57 6	1396.8	65	1396.3	1949653.69	935.50		
	6	11 42 01 6	1390.4	64	1389.67	1931182.7089	939.31		
						Mean,	936.98	2963.53	993.48

* Mean time, New York meridian. On the supposition that the total intensity is the same at both the above localities, the horizontal intensity would indicate a difference of dip still greater than here exhibited. Making 72° 21′ the standard, the other would, by such calculation, be 72° 42′ 9″, instead of 72° 39′ 36″.

Locality, north-east of the Washington monument, and in the south-east corner of the woods.

51. Baltimore, St. Mary's College, April 28, 1841.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
71°39′11″	1	3h.30m.02s.8 P	1598.	68° 8	1596.31	2548205.6161	930.21		
	2	4 07 01 2	1574.8	65	1573.66	2476405.7956	932.58		
	3	4 44 05 4	1279.6	63	1279.38	1636813.1844	933.12		
	4	5 17 02 0	1150.	64 5	1149.66	1321718.1156	932.63		
	5	5 48 02 8	1400.	59	1400.1	1960280.01	930.43		
	6	6 15 58 4	1394.	54 5	1394.67	1945104.4089	932.58		
						Mean,	931.92	2953.82	991.399

Locality, in the midst of the botanical garden of St. Mary's College. Clear, fine, gentle north-west wind. Substratum, primitive rocks. Although Howard's woods and St. Mary's College are less than a mile apart, the local differences are very considerable, and might throw some degree of discredit on the results, were it not that the facts are too well established by independent observers. At both the above localities, Mr. Nicollet made observations, to determine the dip, on the same day, and nearly on the same hours, with a similar apparatus, manipulating, at my request, in the mode which I had adopted. The results were remarkably coincident, as have been others at the same localities. The results are contrasted below:—

AT HOWARD'S WOODS.		ST. MARY'S COLLEGE.	
By Professor Bache, August 24, 1840, dip =	71° 34′ 4″	Professor Bache did not observe at this place.	
By Professor Locke, April 28, 1841,	71 34 3	By Professor Locke, April 28, 1841, dip =	71° 39′ 2″
By Mr. Nicollet, April 28, 1841,	71 34 9	By Mr. Nicollet, April 28, 1841,	71 38 6
By Major Graham, June 10, 1841,	71 31 9	By Major Graham, June 11, 1841,	71 38 8

Those who endeavour to maintain that magnetical dip cannot be very nearly measured by good instruments, carefully used, will find it difficult to account for such a coincidence as is exhibited above. Other localities in the neighbourhood of Baltimore will probably exhibit equal, or perhaps greater, differences than the above.

Bristol, Pennsylvania, Latitude 40° 09′, N.; Longitude, 74° 47′, W.; April 14, 1841.

Dip 72° 27′ 30″. No experiments were made here to ascertain intensity; but, in 1842, (see the series for that year,) that point was determined.

Locality, Professor Vanuxem's, on the bank of the canal. Geology, deep diluvial gravel and clay (?) underlaid by primitive rocks. It will be observed that the dip here is greater than at Philadelphia or Trenton.

V. SERIES, FOR 1842, CINCINNATI TO CAMBRIDGE, (MASSACHUSETTS.)

The intensities at Cincinnati, May 8, 1841, being assumed as unity.

52. Cincinnati, March 31, 1842.

70°20′20″	1	1h.40m.04s.8 A							
	2	10 28 02 4	1536.8	52°	1538.2	2366059.24	1001.82		
	3	10 58 02	1516.4	54	1517.7	2303413.29	1002.62		
	4	11 41 00	1236.	54 5	1236 3	1528684.96	999.13		
	5	12 22 02 4 P	1350.8	55 5	1351.02	1825741.44	999.00		
	6	12 51 59 2	1346.4	57	1346.75	1813735.5625	1000.13		
						Mean,	1000.54	2973.72	996.19

The dip is here so unusual, that I shall use the observations made May 8, 1841, to furnish the unit for the following series.

53. Cincinnati, May 8, 1841.

(See series for 1841.)								1000.	2986.38	1000.
								Logarithm,	1.4751456	

54. Pittsburgh, Latitude 40° 32′, N.; Longitude 80° 02′, W.; April 7, 1842.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°43′12″	1	4*h*.39*m*.0*s*.16 P	1634.4	74°	1631.70	2662444.89	890.29		
	2	3 13 02 4	1612.8	73	1609.8	2591456.04	891.18		
	3	5 47 03 2	1299.2	71	1698.4	1685842.56			
						Mean,	890.73	2998.64	1004.10

Locality, as in previous series.

55. Chambersburg, Pennsylvania, Latitude 39° 55′, N.; Longitude 77° 40′, W.; April 9, 1842.

71°57′04″	1	1*h*.05*m*.03*s*.6	1605.6	73° 5	1602.1	2566724.41	923.49		
	2	1 39 06 4	1585.6	71 0	1583.1	2506205.61	921.49		
	3	2 11 59 6	1289.2	68 5	1288.6	1660489.96	919.82		
	4	2 42 30	1156.4	67 0	1155.9	1336104.81	922.59		
	5	3 10 02 8	1407.6	65 0	1407.1	1979930.41	921.19		
	6	3 43 02 8	1404.0	64 0	1403.5	1969812.25	920.88		
						Mean,	921.57	2975.52	996.36

Half a mile west and a little south of the court house, and five hundred feet south of the stream, just on top of second bank, in a woodland. At two hours thirty minutes had become hazy, wind north-west, gentle. Substratum, dark-blue limestone, highly inclined.

56. Mount St. Mary's College, Emmetsburg, Latitude 39° 41′, N.; Longitude 77° 18′, W.; April 12, 1842.

71°46′20″	1	8*h*.57*m*.02*s*.8 A	1596.4	66°	1595.3	2544982.09	931.39		
	2	4 05 02 4 P	1574.8	72	1572.0	2471184.00	934.55		
	3	10 03 04 A	1280.8	70	1280.	1627920.81	932.39		
	4	9 09 03 6	1150.4	58	1150.7	1324110.49	930.95		
	5	8 25 01 2	1399.6	64 8	1399.1	1957480.81	931.76		
	6	7 51 02	1394.8	61	1394.7	1945208.09	932.52		
						Mean of 5 needles,	931.90	2979.26	997.66

On the left bank of a brook, which, descending the mountain, passes the college. Indurated or metamorphic sandstone.

57. New Haven, Latitude 41° 18′, N.; Longitude 72° 56′, W.; April 21, 1842.

73°29′47″	4	7*h*.23*m*.03*s*.2 A	1211.2	50°	1212.00	1468944.	839.16		
	5	7 56 03 6	1475.2	52 5	1476.00	2178576.	837.20		
	6	8 30 02 4	1469.6	55 7	1470.15	2161341.0225	839.27		
						Mean,	838.54	2951.82	988.44

At a locality called "Highwood," a part of the Hillhouse estate. Substratum, sandstone; trappean rocks within a few miles.

58. Boston, Latitude 42° 22′, N.; Longitude 70° 59′, W.; May 2, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
74°05′40″	1	6*h*.04*m*.03*s*.2 A	1712.4	55°	1713.43	2935842.2649	807.39		
	2	6 45 04 4	1691.6	51 5	1693.68	2868551.9424	805.09		
	3	7 53 10	1377.2	54	1377.58	1897726.6504	804.83		
	4	12 13 01 2 P	1236.4	61	1236.32	1528487.1424	806.47		
	5	12 44 03 6	1504.4	54	1505.03	2265115.3009	805.21		
	6	1 15 00	1500.0	54	1500.79	2252370.6241	805.36		
						Mean,	805.72	2940.02	984.47

Locality, in the garden of the Coolidge House, Bowdoin square. Geology, deep diluvium.

59. Cambridge Observatory, May 4, 1842.

74°14′52″	1	11*h*.42*m*.03*s*.6 A	1714.	48°	1716.5	2946372.25	804.50		
	2	12 20 00 P	1694.8	48	1697.7	2882185.29	801.28		
	3	2 00 04 4	1378.4	50	1379.2	1902192.64	802.94		
	4	2 33 04 4	1234.8	50	1235.6	1526707.36	807.49		
	5	3 05 04 4	1505.6	51 5	1506.5	2269572.25	803.63		
	6	3 43 04 8	1500.8	52 5	1501.8	2255403.24	804.28		
						Mean,	804.02	2961.64	991.71

In the Magnetical Observatory of Mr. Bond. Deep diluvium, superimposed on gneisse rocks. (?)

60. Bristol, Pennsylvania, Latitude 40° 06′, N.; Longitude 74° 47′, W.; May 13, 1843.

72°25′20″	1	7*h*. 7*m*.00*s*.2 P	1634.4	65°	1633.4	2667995.56	888.45	2941.56	984.99

In the middle of Professor Vanuxem's garden. Diluvium of clay, sand, and gravel, superimposed on primitive rocks.

61. Philadelphia, Magnetical Observatory, May 15, 1842.

72° 01′	1	1*h*.52*m*.04*s*.8 P	1608.8	66°	1608.03	2585760.4809	916.70		
	2	2 36 59 6	1585.2	56 5	1586.01	2515396.	918.13		
	3	3 24 02	1290.4	52 5	1291.00	1666681.	916.40		
	4	3 55 00 4	1156.4	52	1157.00	1338649.	920.83		
	5	4 25 00 0	1409.3	53	1410.30	1988946.09	917.02		
	6	5 00 58 8	1404.4	52 5	1405.30	1974868.09	918.02		
						Mean,	917.85	2972.88	995.48

At the Observatory, near the Girard College. Rain commenced about the close of the observations. There is a very close coincidence of the above observations and those made in March, of the preceding year, both in the details and in the mean results. The horizontal intensity of 1841 was 917.84 and 917.11, and, as above, in 1842, 917.85.

VI. SERIES, 1843, CINCINNATI, (OHIO,) TO MICHIGAN, AND WISKONSIN, LAKE SUPERIOR.

63. Cincinnati, August 21, 1843.

70°25′30″	4	11*h*.17*m*.00*s*. A	1110.8	74°	1109.52	1231034.6304	1001.33		
	5	11 48 03 6	1352.8	75	1351.16	1825633.3456	999.05		
	6	12 31 00 0 P	1347.6	75 5	1345.55	1810504.8025	1001.91		
						Mean,	1000.76	2986.98	1000.20

The above being a comparison of the results obtained at the above date with those of May 8, 1841, assumed as unity, or, rather, as 1000, exhibit very favourably the permanency of the magnetism of the needles; and show it to be quite immaterial which, hereafter, be made the standard of comparison—the observations of May 8, 1841, or those of August 21, 1843. The following calculations will be made by using the above squares as dividends, and will, therefore, refer to Cincinnati, August 21, 1843, as unity. The observations were made at the usual locality, in Longworth's garden. Weather clear and calm.

64. Huron, Ohio, Latitude 41° 21′, N.; Longitude 82° 27′, W.; June 6, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73°00′00″	4	9*h*.41*m*.02*s*.4 A	1180.0	63°5	1179.41	1391007.9481	884.99		
	5	10 28 04 0	1440.0	66 5	1439.11	2071037.5921	881.50		
	6	11 16 04 0	1432.8	69 5	1431.36	2048791.4496	883.69		
						Mean,	883.40	3021.50	1012.32

Locality, the low peninsula on the east side of the mouth of the Huron river. The immediate soil is diluvium, but, at no great depth, the "black shale" must exist.

65. Detroit, (Michigan,) Latitude 42° 25′, N.; Longitude 82° 56′, W.

73° 32′	4	8*h*.21*m*.02*s*.4 A	1200.	66°5	1199.3	1438320.4900	855.88		
	5	8 48 03 2	1462.	68 0	1460.94	2134345.6836	855.36		
	6	9 22 01 2	1456.4	72 0	1454.63	2115948.4369	855.64		
						Mean,	855.63	3018.55	1011.34

Near the Pontiac rail-road, about one-fourth of a mile north of the bend. Ancient lake bed, similar to a diluvium. Surface level and wet. Substratum, at, perhaps, one hundred feet below the surface, the cliff limestone. Clear, fine, wind south-west.

66. Ann Arbor, (Michigan,) Latitude 42° 16′, N.; Longitude 83° 39′, W.; June 13, 1843.

73°12′36″	4	6*h*.29*m*.02*s*.0 P	1185.2	71°5	1184.12	1402140.1744	877.96		
	5	6 59 01 2	1443.6	68 0	1442.56	2080979.3536	877.77		
						Mean,	877.86	3039.00	1018.20

In the woods south-east of the university. Geology, diluvium of large bowlders. On the supposition of equal intensities at Ann Arbor and at Detroit, the calculated dip at the former place would be 73° 07′ 30″, 5′ 06″ less than the observed dip.

67. Ann Arbor, June 14, 1843.

73°14′46″	6	6*h*.07*m*.59*s*.2 A	1437.2	57°5	1437.28	2065773.7984	876.43	3040.40	1018.64

About three hundred feet east of the previous locality.

68. Detroit, Chancellor Farnsworth's Garden, June 15, 1843.

73°32′25″	4	3*h*.05*m*.00*s*.5 P	1200.2	67°	1199.45	1438680.3025	855.67		
	5	3 36 04 0	1462.8	66	1462.00	2137444.0000	854.11		
						Mean,	854.89	3017.17	1010.90

Geology, deep lacustrine deposite, underlaid by the cliff limestone. Cloudy, and a slight, misty rain towards the end of the time.

69. Mackinaw Island, Latitude 45° 54′, N.; Longitude 84° 10′, W.; June 18, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.		Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
76°38′51″	4	9h.18m.03s.6	A	1312.0	71°5	1310.8	1718196.6400	716.47		
	5	10 00 04 8		1599.6	75 0	1597.66	2552517.4756	715.23		
	6	10 49 00 0		1593.2	79 0	1590.28	2528990.4784	715.90		
							Mean,	715.87	3100.4	1038.75

About three hundred yards west of the highest point of the island. Geology, the cliff limestone, very much disturbed and broken. Clear, calm, beautiful. Some calm cirri.

70. Sault de St. Marie, Latitude 46° 31′, N.; Longitude, 84° 32′, W.

77°30′15″	4	11h.55m.02s.	A	1359.6	86°	1357.08	1841666.7264	668.43		
	5	12 29 06	P	1655.2	89	1651.57	2727683.4649	669.29		
	6	1 05 06		1647.6	90	1643.00	2699449.0000	670.69		
							Mean,	669.47	3094.10	1036.65

About four hundred yards west of the mill-race, and near the proposed canal around the Sault. Geology, diluvium, superimposed on horizontally stratified sandstone.

71. Encampment about ten miles below St. John's River, Lake Superior; Latitude 46° 44′, N.; Longitude 87° 43′, W.; July 2, 1843.

76°58′19″	4	8h.06m.04s.	A	1330.	60°	1329.78	1768314.8484	696.16		
	5	8 59 00		1620.	60	1619.73	2623525.2729	695.87		
	6	9 35 08		1613.6	61	1613.2	2602414.2400	695.70		
							Mean,	695.91	3087.10	1034.10

In a swamp of cedar, fir, and white birch trees, underlaid by horizontally stratified sandstone, but with trappean rocks not far distant both ways on the lake shore.

At this locality, a small island, distant about three miles, bears north 69° east, and, another, distant half of a mile, bears north 7° west. The last is so near the shore as to leave a channel not more than one hundred and twenty yards wide. A small rivulet puts in between our encampment and the point opposite this island. Clear, wind north-west, strong.

72. Houghton's River, near Copper Harbour, Latitude 47° 28′, N.; Longitude 88° 01′, W.; July 8, 1843.

77°20′45″	4	12h.38m.02s.4	P	1356.0	71°5	1354.77	1835401.7529	670.71		
	5	1 15 01 6		1650.8	72 0	1648.35	2717657.7225	671.91		
	6	2 00 04 8		1644.4	72 0	1642.4	2697477.7600	671.18		
							Mean,	671.27	3064.30	1026.62

This locality is designated on the map by a circlet and the letter *a*. Substratum, metamorphic conglomerate, approaching, apparently, to trap rock in its nature. Clear, wind north-west.

73. Magnet Inlet, Porter's Island, Copper Harbour, Latitude 47° 29′ N.; Longitude 88° 02′ W.; July 8, 1843.

78°45′20″	4	11h.48m.02s.4	A	1411.2	62°	1410.8	1990356.64	618.50		
	5	12 21 00 4	P	1717.6	60	1717.32	2949187.9824	619.03		
	6	1 10 04 8		1709.6	58	1709.00	2920681.0000	619.89		
							Mean,	619.14	3175.10	1063.80

This station is designated, on the map of Porter's Island, as station No. 7. Wind north-west, strong.

74. Magnet Inlet, July 11, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
78°45′20″	4	6*h*.28*m*.04*s*. P	1408.4	66°	1407.62	1981394.0644	621.29		
	5	6 54 00	1716.0	61 5	1715.54	2943077.4916	620.31		
	6	Not used.				Mean,	620.80	3183.62	1066.66

The geology, &c., of this locality will be discussed after we shall have presented all of the observations made about Copper Harbour.

75. Five hundred feet east of Magnet Inlet, July 15, 1843.

78°37′30″	4	4*h*.37*m*.00*s*. P	1406.	74°	1404.5	1972620.2500	624.06		
	5	5 00 04 4	1712,	68	1710.77	2926733.9929	623.77		
	6	5 32 01 6	1706.	66	1704.82	2906411.2324	622.93		
						Mean,	623.59	3160.70	1059.31

In a grove of small spruce and fir trees. Station 8, on map of Porter's Island.

76. On the Isthmus between the lower end of Copper Harbour and the "White rock," July 11, 1843; Latitude 47° 29′, N.; Longitude 88° 00′, W.

78° 28′	4	10*h*.48*m*.00*s*. A	1399.6	71°	1398.37	1955438.6569	629.54		
	5	11 22 04 4	1704.0	72	1703.30	2901230.8900	629.26		
	6	12 01 04 0	1696.0	71	1694.08	2869907.0464	630.86		
						Mean,	629.88	3150.38	1055.50

Substratum, metamorphic conglomerate. The experiments were made in the shadow of the trunk of a dead tree.

77. Near General Cunningham's Office, and eleven hundred feet westwardly of Magnet Inlet, on Porter's Island, July 8, 1843. Station No. 3.

77°13′30″	4	6*h*.53*m*.00*s*.8 P	1309.6	58°	1309.56	1714947.3936	717.82		
	5	7 23 03 6	1596.	55	1596.3	2548173.69	716.44		
	6					Mean,	717.13	3243.20	1086.58

It appears from the preceding that there are great variations of the magnetic elements on, and about, Porter's Island, within very small distances. The mean of the total intensity at five different stations, about Copper Harbour, will be 3158.90, as follows:

1. At Houghton's River,	3064.30
2. At Magnet Inlet,	3175.10
3. Five hundred feet east of Magnet Inlet,	3160.70
4. Isthmus of the White Rock,	3151.00
5. Near the Agency Office,	3243.20
Mean,	3158.90

Assuming the above mean as the total intensity at (Copper Harbour) Magnet Inlet, we have by the horizontal intensity given above, "619.14," and, by the application of the formulæ already given, the calculated dip 78° 41′ 49″, within 3′ 31″ of the observed dip at the same locality. Thus the unusual dip at this place is proved by two sets of direct observations, and by the vibrations of three intensity needles, also twice repeated.

In order to examine, more in detail, the changes of the dip in various parts of the island, I selected that needle, (No. 2,) and the mode of using it, which gave, at a single

observation, a result nearest to the mean of a complete series, and with it ascertained the dip at several localities noted on the map of Porter's Island, beginning at the extreme western end as follows:

Station No.	1,	77° 10′	+ 7′ =	77° 17′		
" "	2,	77 07	+ 7 =	77 14		
" "	3,			77 13	30″	Complete Series at General Cunningham's Office.
" "	4,	77 13.5	+ 7 =	77 20	30	
" "	5,	77 20	+ 7 =	77 27		
" "	6,	77 35	+ 7 =	77 42		
" "	7,	78 38	+ 7 =	78 45		
" "	8,			78 37	30	A full series.
" "	9,	78 25	+ 7 =	78 32		
			Mean,	77° 47′		

Here, between the sixth and the seventh station, a distance of only four hundred and twenty feet, there is an increase of the dip to the extent of 1° 02′!

78. Mouth of Eagle River, Latitude 47° 27′, N.; Longitude 88° 23′, W.; July 13, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
77°54′30″	4	10*h*.26*m*.59*s*.6 A	138.0	81°	1378.	1898884.0000	648.29		
	5	12 33 59 6 P	1681.2	88 5	1678.75	2818201.5625	647.80		
	6	12 02 02 8	1674.8	85 0	1670.85	2791739.7225	648.52		
						Mean,	648.20	3094.40	1036.72

On the sandy beach at the mouth of a small river. As it was raining at the commencement of the experiments, they were made within the tent, upon which the sun shone, as soon as the clouds and fog disappeared. Substratum, probably metamorphic conglomerate.

79. La Pointe, Magdalene Island, W. T., Latitude 46° 47′, N.; Longitude 90° 58′, W.; July 21, 1843.

76°56′07″	4	10*h*.48*m*.02*s*. A	1324.2	80° 0	1320.28	1743139.2784	706.21		
	5	11 19 05 6	1613.2	85 0	1610.12	2592486.4144	704.20		
	6	11 56 02 8	1608.	83 5	1604.4	2574099.3600	703.74		
						Mean,	704.72	3117.5	1044.50

About half a mile eastwardly of the mission house, amongst the shady evergreens. Geology, lacustrine diluvium superimposed on sandstone.(?) Clear, wind south, unusually warm for the climate.

80. Ontonagon River, Latitude 46° 52′, N.; Longitude 89° 31′, W.; July 26, 1843.

77°13′10″	4	6*h*.27*m*.59*s*.6 A	1340.	64°	1339.43	1794072.7249	686.17	3101.81	1039.23

On the east side of the mouth of the river. Alluvium, superimposed on sandstone. Clear, wind north-west.

81. Rock Harbour, Isle Royale, Latitude 48° 06′, N.; Longitude 88° 47′, W.; July 28, 1843.

78°07′36″	4	6*h*.29*m*.04*s*.4 P	1380.4	60°	1380.17	1904869.2289	646.25		
	5	7 52 00 8	1680.4	58	1680.35	2823576.1225	646.56		
						Mean,	646.40	3141.70	1052.60

On the north side of the harbour, in a small opening amongst the fir trees, growing almost without soil, on a metamorphic sand rock, approaching, in its character, to trap rock.

82. Near Cleveland, Ohio, at Professor Kirtland's, Latitude ; Longitude ; August 4, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73° 08′	5	3*h*.52*m*.04*s*.4 P	1442.	80°	1439.74	2072851.2676	880.74		
	6	4 30 01 2	1436.8	77	1434.68	2058306.7024	879.60		
						Mean,	880.17	3033.54	1016.34

Near the lake, in a woodland. Substratum, the "black shale."

As the intensity at Copper Harbour is evidently high, compared with that which shows itself at the other localities along the south shore of the lake, it is proper, perhaps, to make a group of all the others, excluding those of the harbour, as from one to five, inclusive, in the following table.

SUMMARY, BY GROUPING.

Title of the Group.	Names of Places.	Latitude.	Longitude.	Dip.	Total Intensity. LOCKE.	Total Intensity. SABINE.
Five Stations of the South Shore.	1. Sault St. Marie,	46° 31′	84° 32′	77°30′15″	1036.65	
	2. Encampment,	46 44	87 43	76 58 19	1034.10	
	3. Mouth of Eagle River,	47 27	88 23	77 54 30	1036.72	
	4. Mouth of Ontonagon,	46 52	89 31	77 13 10	1039.23	
	5. Lapointe,	46 47	90 58	76 56 00	1044.50	
	Mean of the above,	46°52′12″	88°08′36″	77°18′27″	1038.24	1882.64
Five Stations at Copper Harbour.	6. Houghton's River,	47 28	88 01	77 20 45	1026.62	
	7. Magnet Inlet, (7)	47 29	88 01	78 45 20	1065.23	
	8. 500 ft. E. of Mag. Inlet, (8)	47 29	88 01	78 37 30	1059.31	
	9. Isthmus,	47 29	88 00	78 28 00	1055.50	
	10. United States Agency,	47 29	88 01 10	77 13 30	1086.58	
	Mean of the above,	47°28′48″	88°00′50″	78°05′01″	1058.65	1919.65
	11. Isle Royale,	48 06	88 47	78 07 36	1052.60	1908.08
	Mean of all the above observations on Lake Superior,	47°15′32″	88°10′43″	77°44′00″	1048.82	1901.82

The following table exhibits the total intensity of several of the most important places, expressed, both in the values referred to Cincinnati, and in those used by Colonel Sabine.

Stations.	Latitude.	Longitude.	Dip.	Total Intensity. Cincinnati 1000.	Total Intensity. SABINE.	Observer.	Year.
Casmar, South America,	9°38′ S.	78°85	5°00′ S.	551.40	1000.00	Humboldt	1802
New York,	40 43 N.	74 01	72 41 N.	994.30	1803.00	Locke	1841
Cincinnati,	39 06	84 22	70 27 00	1000.00	1813.30	"	1841
Williamstown, Kentucky,	38 36	84 22	70 04 07	993.25	1801.06	"	1840
St. Louis, Missouri,	38 36	90 15	69 31 26	997.35	1808.35	"	1839
Davenport, Iowa,	41 30	90 35	71 55 00	1012.91	1836.71	"	1839
Mean of five stations on the South Shore,	46 52 12	88 08 36	77 18 27	1038.24	1882.64	"	1843
Five stations on Copper Harbour, L. S.,	47 28 48	88 00 50	78 05 01	1058.65	1919.65	"	1843
Isle Royale,	48 06	88 47	78 07 36	1052.60	1908.08	"	1843
Mean of all the stations on Lake Superior,	47 15 32	88 10 43	77 44 00	1048.82	1901.82	"	1843

COMPARISON OF THE INTENSITIES, AS GIVEN IN THE PRECEDING TABLES, WITH THOSE REPORTED TO THE BRITISH ASSOCIATION IN 1838, BY MAJOR SABINE, R.A.

In Major Sabine's Report the intensity of some place near the equator, as observed by Humboldt, in 1802, has been assumed as unity, and, on page forty-three, we find that of New York to be 1803.0. By the unit assumed in the above tables, the intensity at the same locality, Columbia College, New York, is expressed by 994.3. Then we have (Locke,) 994.3 : (Sabine,) 1803.0 : : (Locke,) 1000 : (Sabine,) 1813.3, the last being the intensity at Cincinnati, according to Colonel Sabine's unit. Hence to reduce any total intensity, a, given in the preceding tables, where that at Cincinnati is assumed as unity, to a comparison with the standard or unit assumed by Major Sabine, we have the following formula: $\frac{18133}{10000}\,a = x$, the required value. By the application of this formula to the intensity observed on Porter's Island, in Lake Superior, 1086.58, we obtain 1970.29. Situated, as this locality is, nearly in the centre of the great ellipsoid described by Major Sabine in his plates, Nos. 3 and 4, by the lines representing the intensities 1.700 and 1.800, and being the highest magnetical intensity yet observed on the earth, so far as known to me, we deem the observations worthy of peculiar attention. But the more correct result will be obtained, not by an extreme instance, but by the mean of a group, as that of the five stations given on a previous page, "3158.90," which, reduced to the Cincinnati standard of unity, becomes 1058.02, and, reduced again by the above formula, to Colonel Sabine's standard, is equal to 1918.5, or, as it is pointed on Colonel Sabine's charts, 1.9185. By a similar reduction of the temperature at Isle Royale, we have 1.90808. As the intensity at Copper Harbour is evidently high, compared with that which shows itself at the other localities along the south shore of the lake, it is proper, perhaps, to make a group of all the others, excluding those of the Harbour.

It appears, by the intensity at Cincinnati and Williamstown, in Kentucky, that the isodynamic line of New York passes between those two places, about twenty-five geographic miles south of Cincinnati, and five north of Williamstown. By a calculation of the change of intensity proportional to change of latitude, from Davenport to St. Louis, it appears that the same isodynamic line crosses the Mississippi at a point thirty-two geographic miles south of St. Louis, namely, in latitude 38° 04′, north.

From Lexington, in Kentucky, to Isle Royale the difference of latitude is exactly ten degrees; and the difference of intensity, according to my unit, is 67.18, or, 6.718 to each degree. According to Colonel Sabine's unit, the whole difference will be 0.12122, or, 0.012122 to each degree.

GENERAL SUMMARY.

I. SERIES, FOR OHIO, 1838.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total intensity Hor. being 1000.	Horizontal Intensity	Total Intensity by Sabine's unit.
1	March 20,	Cincinnati, - - - - -	39°06′N.	84°22′W.	70°28′08″	1000.	2991.1	1000.	1.8138
2	" 26,	Dayton, - - - - - -	39 44	84 17	71 22 42	958.20	3001.0	1003.2	
3	" 29,	Springfield, - - - - -	39 54	83 51	71 27 23	949.4	2984.3	997.8	
4	" 30,	Urbana, - - - - - -	40 05	83 48	71 39 45	953.26	3027.9	1012.2	
5	April 2,	Columbus, - - - - -	39 57	83 02	71 04 52	966.64	2981.3	996.72	

II. SERIES FOR IOWA, &c., 1839.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total Intensity, Hor. being 1000.	Total Intensity.	Total Intensity by Sabine's unit.
6	Aug.18,1840,	Cincinnati, - - - -	39°06′	84°22′	70°27′26″	1000.	2989.40	1000.	1.81330
7	Sept. 6,	St. Louis, - - - -	38 36	90 02	69 31 26	1042.97	2981.50	997.35	1.80849
8	" 13,	Davenport, - - - -	41 30	90 25	71 55	939.90	3028.03	1012.91	1.83671
9	" 15,	Davenport, - - - -	41 30	90 27	71 55 15	937.92	3021.32	1011.00	
10	" 23,	Lost Grove, - - - -	41 39	90 09	72 02 26	935.96	3028.46	1015.39	
11	" 25,	Wapsipinnicon, - -	41 44	90 23	72 15 00	930.16	3051.06	1020.61	
12	" 27,	Iron Ore Bed, - - -	41 55	90 40	72 50 30	908.52	3079.59	1030.16	
13	" 30,	Brown's Settlement, -	42 02	91 06	72 21	918.11	3028.05	1012.92	
14	Oct. 2,	Makoqueta, - - - -	42 14	90 57	72 43 37	903.41	3042.57	1017.77	
15	" 5,	Farmer's Creek, - -	42 13	90 23	72 36	914.36	3057.64	1022.82	
16	" 8,	White Water, - - -	42 18	90 38	72 55	892.70	3038.85	1016.53	
17	" 9,	N. B. Makoqueta, - -	42 23	90 52	72 51	889.71	3017.25	1009.31	
18	" 14,	Dubuque, - - - -	42 29	90 23	73 05	880.55	3028.66	1013.00	
19	" 20,	Forks of Little Makoqueta,	42 31	90 31	73 08	881.27	3037.34	1016.02	
20	" 22,	Turkey River, - - -	42 42	90 48	73 11	873.19	3018.18	1009.	
21	" 24,	Prairie du Chien, - -	43 01	90 53 30	73 16 35	876.34	3045.44	1018.73	
22	" 29,	Blue Mound, (W. T.,)	43 01	89 38	73 41	854.00	3038.54	1017.43	
23	Nov. 2,	Madison, (W. T.,) - -	43 05	89 06	74 03	852.06	3102.25	1037.76	
24	" 5,	Mineral Point, - - -	42 50	89 54	73 20 37	868.60	3030.40	1013.70	
25	Sep.24,1840,	Cincinnati, - - - -	39 06	84 22	70 29 11	998.12	2984.40	998.31	
Mean, excluding Cincinnati & St. Louis,			42°18′10″	90°37′38″	72°50′			1017.38	

III. SERIES OF 1840, OHIO, KENTUCKY, &c.

26	Aug. 18,	Cincinnati, - - - -	39°06′	84°22′	70°27′26″	1000.	2989.40	1000.	
27	" 20,	Hamilton, Ohio, - -	39 23	84 32	70 58	978.33	2999.90	1003.50	
28	" 21,	Dayton, Ohio, - - -	39 44	84 17	71 22	954.40	2987.10	999.15	
29	" 22,	Piqua, Ohio, - - -	40 06	84 13	71 35 50	946.10	2997.30	1002.60	
30	" 24,	Lebanon, Ohio, - - -	39 26	84 06	71 02 45	972.04	2993.63	1001.07	
31	" 25,	Mason, Ohio, - - -	39 22	84 13	70 54 12	976.96	2986.16	998.90	
32	" 26,	Cincinnati, - - - -	39 06	84 22	70 27 54	997.03	2981.74	997.43	
33	Sept. 1,	Williamstown, Kentucky,	38 36	84 22	70 04 07	1012.20	2969.27	993.25	
34	" 2,	Lexington, Kentucky, -	38 06	84 18	69 54 30	1012.00	2945.94	985.42	1.78686
35	" 3,	Clay's Ferry, Kentucky,	37 54	84 18	69 49 00	1020.35	2957.32	989.27	
36	" 4,	Frankfort, Kentucky, -	38 14	84 40	69 54 53	1015.06	2954.76	988.74	
37	March 11,	Louisville, Kentucky, -	38 03	85 30	69 54 26	1023.38	2978.90	996.48	
38	Sept. 10,	Vernon, Indiana, - -	37 57	87 47	68 56 17	1064.61	2964.51	991.33	
39	" 11,	New Harmony, - -	38 11	87 48	69 03 37	1058.10	2961.80	990.76	
40	" 16,	Princeton, Indiana, - -	38 23	87 30	69 22 48	1044.68	2966.40	992.29	
41	" 18,	Vincennes, Indiana, -	38 43	87 25	69 51 10	1026.03	2978.89	998.54	
42	" 20,	Paoli, Indiana, - - -	38 35	86 25	69 33 47	1031.84	2953.68	988.04	
43	" 24,	Cincinnati, - - - -	39 06	84 22	70 29 11	996.88	2984.40	998.31	
Mean, including Cincinnati but once,			38°45′42″	85°21′37″	70°11′			995.00	

IV. SERIES, 1841, CINCINNATI.

44	May 8,	Cincinnati, - - - -	39° 06′	84° 22′	70°26′11″	999.58	2983.88	*998.56	
45	" 8,	Cincinnati, - - - -	39 06	84 22	70 26 11	1000.	2986.38	1000.*	
46	March 30,	Philadelphia, - - -	39 57	75 10	72 00 10	917.84	2970.80	994.78	
47	" 31,	Philadelphia, - - -	39 57	75 10	72 01 20	917.11	2971.38	994 97	
48	" 22,	Pittsburgh, - - - -	40 32	80 02	72 43 30	891.47	3002.00	1005.23	
49	April 26,	Philadelphia, - - -	39 57	75 10	71 59	917.43	2965.21	994.32	
50	" 23,	Trenton, New Jersey,	40 13	74 40	71 59	921.60	2979.60	997.76	
51	" 19,	Newark, New Jersey,	40 43	74 10	72 49	878.45	2974.46	995.67	
52	" 19,	New York, - - - -	40 43	74 01	72 41	883.52	2969.20	994.28	
53	" 20,	Harlaem, - - - -	40 49	74	72 39 36	882.84	2961.90	991.80	
54	" 20,	New Asylum, - - -	40 48		72 21	900.26	2969.18	994.24	
55	" 28,	Baltimore, - - - -	39 17	76 37	71 34 06	936.98	2963.53	993.48	
56	" 28,	Baltimore, - - - -	39 17	76 37	71 39 11	931.92	2953.82	991.40	

* That of August 18, 1840, being assumed as unity in this series.

V. SERIES, 1842, CINCINNATI TO CAMBRIDGE, (MASSACHUSETTS.)

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total Intensity, Hor. being 1000.	Total Intensity.	Total Intensity by Sabine's unit.
57	March 31,	Cincinnati, - - - -	39° 06′	84° 22′	70°20′20″	1000.54	2973.72	996.19	
58	My.8,'41,	Cincinnati, - - - -	39 06	84 22	70 26 11	1000.	2986.38	1000.	
59	Ap. 7,'42,	Pittsburgh, - - - -	40 32	80 02	72 43 12	890.73	2998.64	1004.10	
60	April 9,	Chambersburg, - - -	39 55	77 40	71 57 04	921.57	2975.52	996.36	
61	" 12,	Mt. St. Mary's College,	39 41	77 18	71 46 20	931.90	2997.26	997.66	
62	" 21,	New Haven, - - -	41 18	72 56	73 29 47	838.54	2951.82	995.18	
63	May 2,	Boston, - - - - -	42 22	70 59	74 05 40	805.72	2940.02	984.47	
64	" 4,	Cambridge, - - - -			74 14 52	804.02	2961.64	991.71	
65	" 13,	Bristol, - - - - -	40 06	74 47	72 25	888.45	2941.56	984.99	
66	" 15,	Philadelphia, - - -			72 01	917.85	2972.88	995.48	

VI. SERIES OF 1843, LAKE SUPERIOR, &c.

67	Aug. 21,	Cincinnati, - - - -	39° 06′	84° 22′	70°25′30″	1000.76	2986.98	1000.20	*
68	" 21,	Cincinnati, - - - -	39 06	84 22	70 25 30	1000.	2986.98	1000.	
69	June 6,	Hudson, Ohio, - - -	41 26	82 27	73 00 00	883.40	3021.50	1012.32	
70	" 12,	Detroit, Michigan, - -	42 25	82 56	73 32	855.63	3018.55	1011.34	
71	" 13,	Ann Arbor, - - - -	42 16	83 39 W.	73 12 36	877.86	3039.00	1018.20	
72	" 14,	Ann Arbor, - - - -	42 16	83 39	73 14 46	876.43	3030.40	1018.64	
73	" 15,	Detroit, - - - - -	42 25	82 56	73 32 25	854.89	3017.17	1010.90	
74	" 18,	Mackinaw, - - - -	45 54	84 10	76 38 51	715.87	3100.40	1038.75	
75		Sault St. Marie, - -	46 31	84 32	77 30 15	669.47	3094.10	1036.65	
76	July 2,	Encampment, L. Superior,	46 44	87 43	76 58 19	695.91	3087.10	1034.10	
77	" 8,	Houghton's River, - -	47 28 N.	88 01	77 20 45	671.24	3064.30	1026.62	
78	" 8,	Magnet Inlet, - - -	47 28½	88 01 W.	78 45 20	619.14	3175.00	1063.80	
79	" 11,	Magnet Inlet, - - -	"	"	78 43 20	620.80	3183.62	1066.66	
80	" 15,	500 ft. east of Mag. Inlet,	"	"	78 37 30	623.59	3160.70	1059.31	
81	" 11,	Isthmus, - - - - -	"	88 00	78 28	629.88	3150.38	1055.50	
82	" 8,	United States Agency,	"	"	77 13 30	717.13	3243.20	1086.58	1.97029
83	" 13,	Eagle River, - - -	47 27	88 23	77 51 30	648.20	3094.40	1036.72	
84	" 21,	La Pointe, - - - -	46 47	90 58	76 56	704.72	3117.5	1044.50	1.89400
85	" 26,	Ontonagon, - - - -	46 52	89 31	77 13 10	686.17	3101.81	1039.23	
86	" 28,	Isle Royale, - - - -	48 06	88 47	78 07 36	646.40	3141.7	1052.60	1.90808
87	Aug. 4,	Cleveland, Ohio, - -			73 08	880.17	3033.54	1016.34	

* The above quantities refer to "Cincinnati, May 8, 1841," as unity. In the following series the standard assumed is that of Cincinnati, August 21, as unity, both of horizontal and total intensity, as follows.

GEOLOGY OF PORTER'S ISLAND AND COPPER HARBOUR.

The geology of this and the neighbouring regions, has been well treated by Dr. Houghton, the geologist of the state of Michigan, to whose writings we refer the reader for information more general than it is my object, in this article, to present. The rocks of Copper Harbour, and indeed of the whole of Kewenon peninsula, are decidedly metamorphic, showing every degree of change produced by igneous agency, from unchanged sandstone to compact greenstone. The original stratification is, mostly, more or less evident, presenting in the various superimposed layers, an inexplicable variety, some layers bearing evidence of semi-fusion and a correspondent degree of induration and endurance, while others seem scarcely to have been altered, still remaining soft and yielding readily to atmospheric agency, and especially to the assaults of the waves from the lake. Whether these differences have been produced by an unequal distribution of the heat, or by an original difference in the layers of the strata, some being of a nature more suscep-

tible of change by heat, I was unable to determine. At Copper Harbour the strata dip very regularly to the northward, at an angle of about 30°, and consequently they plunge, on one side, under the lake itself; and rising on the other side above the waters form a rocky slope well calculated to receive, lift up, and gradually destroy the mighty waves which the strong north-west wind often throws upon the coast. These two characters, the alternation of soft and hard layers, and their inclination in such manner as to bring those layers alternately to the surface, afford the proper key to the topography of the coast. It is evident that the lake must necessarily act more rapidly on the softer than on the harder strata, and that the waves will, by breaking over, or by a narrow breach through, the barrier formed by a harder stratum, break down and remove a soft stratum interiorly, as it were, and thus form elongated bays with but a narrow inlet. As the action proceeds, the hard stratum itself giving way, at numerous points, will be cut up into numerous islands, situated in a chain, still protecting a bay or harbour within. These islands, too, when seen endwise, present, with great uniformity, the appearance of saw-teeth, rising, as they do, gradually on the slope next to the lake, and dropping abruptly on the side next to the shore. These characters are well exhibited at Copper Harbour and at Agate Harbour, a few miles to the westward of it. Copper Harbour itself seems to have been formed by the removal of a softer stratum of metamorphic sand rock, while Porter's Island is a part of the barrier, formed by the outcropping of a harder layer.

DESCRIPTION OF THE PLATES.

Plate No. 43, is a chart of the United States, on a conical surface, passing, unrolled, through the parallels of twenty-five and fifty degrees of north latitude. I have since had occasion to prefer a chart on a tangent to that on a chord, the difference would have been that the meridians would have been somewhat more distant than they actually are. The object of this chart is to exhibit to the eye the approximate configuration, especially of the isodynamic lines; farther than this I attach no especial importance to them. It appears that they form ellipses more or less concentric; a fact anticipated, and clearly pointed out by Colonel Sabine, in 1838, from very distant surrounding observations made on the Atlantic, Pacific, and at Baffin's Bay. My observations have fixed, more precisely, those lines, have determined the value of the intensity at particular localities, and have shown that the centre, or axis of greatest intensity, is at, or near to, Lake Superior. It will be seen by the results of my researches, engraved in numbers on the chart, how far I have actual authority for the chart lines. So far as they extend beyond the limits of the United States, and into the British possessions, they are projected with nothing more than a general consistency with distant observations. The researches conducted under the government of Great Britain will presently settle that part of the chart, in a most perfect manner. The unit assumed for the expression of the total intensity is that of Cincinnati, which has been called 1000. The line passing through New York was found to have the intensity expressed by 994, and from this proceeding inwardly, towards Lake Superior, lines have been drawn at 1004, 1014, 1024, &c., having a common difference of 10. Upon every line, I have also marked its value according to Baron Humboldt's unit, adopted by Colonel Sabine, in his Report of 1838, which I have designated by the name Sabine, or the initial S.

The point, line, or surface of maximum intensity, is the subject now of no small interest, and my observations, together with Lieutenant Lefroy's, as alluded to in Colonel Sabine's letter, seem to settle the question that it is at or near to Lake Superior; but whether within the limits of the United States, or of British America, is not positively determined. So abrupt and irregular are the magnetic changes, in very small distances in the region of the lake, that a true mean result requires many varied observations. It is like determining the mean level of a very uneven and broken country by taking random elevations; as by descending upon various unknown points in the night, with a balloon, and determining their altitude barometrically, without being able to discriminate whether you are upon a hill or in a valley; a species of surveying evidently requiring a multitude of observations to furnish a correct mean. I have drawn the chart of this part according to the present conditions of knowledge, and leave it open to such modifications as future developments may demand. I have represented an "axis" of total intensity, as suggested by Colonel Sabine's letter, uniting the point of maximum intensity discovered by Lieutenant Lefroy, in the line of his journey, with that discovered by myself in a line intersecting that through which he passed, but extending scarcely beyond it. My desire to return and multiply observations in that region this summer is almost uncontrollable, but my private means will not permit it, and I despair of any assistance from government, or from any other source. While Great Britain is sending out naval expeditions, and encompassing the earth with her magnetical researches, I feel impatient that there is no means by which I can be aided in completing a kind of magnetical reconnoisance of our own country. I do not ask to be paid for it, I merely ask to be helped a little;—I am still willing to make a personal sacrifice.

"The line of equal variation," placed on this chart, is not the result of my own observations, but is copied from a chart by Professor Loomis, published in Silliman's Journal. It is introduced merely to illustrate the popular definitions with which this paper commences. The line of equal dip is also introduced for popular explanation, but it was the result of my own experiments. More lines of equal dip might have been introduced, but I have chosen to designate the dip in numbers, and leave the chart clear of the confusion necessarily arising from the intersection of different systems of lines.

After all, I fear that my readers will suppose that I attach more importance to the chart lines than they are worth. This point will be determined by the support which they derive from the observations; and it will be seen that they represent to some extent rather what is desirable than what has been attained. The southern line, 994, has a number of observations to support it from New York to the Mississippi. The second one, 1004, has scarcely more than two. The third, 1014, has two groups, one in Iowa and the other about Lake Erie. The fourth, 1024, is sustained by one group, only. The fifth, 1034, has only two observations near to it, at Mackinaw and at the Sault St. Marie. The sixth, 1044, is determined by the observations at La Pointe, while the other observations along the line are too low. The axis or maximum line, is sustained by the mean of numerous observations at Copper Harbour, and by one observation on Isle Royale. It may be, too, that the high intensity observed at Copper Harbour will not be sustained by that of the surrounding regions, when it would appear, to speak figuratively, that at Copper Harbour there is an isolated mountain, an outlier of high intensity. Although to make an accu-

rate chart calls for a multitude of observations still to be made, yet it is not useless to excite the inquiry, *is the line traced right, or wrong?* and, at the same time, to point out where observations are needed, the most readily to determine the chart lines. Could the results of the observations made by Major Graham, in the north-east parts of the United States, by Professor Bache, in Pennsylvania, New York, and along the St. Lawrence, and those in the western portions by Professor Loomis, be united, and my own added, the chart would be more extensively determined.

Plate No. 44.—This is copied from Major Sabine's Report. It shows the relative position of the astronomic pole, the pole of dip and of convergence, discovered by Ross, and the pole of maximum intensity, approximately settled by the observations of 1843. These are nearly on the same meridian, and not far from twenty degrees asunder; 85° to 90° west longitude, and 47½°, 70°, and 90°, north latitude. I have also retained Colonel Sabine's lines of 1.6, 1.7, and 1.8, showing that his anticipation of the general configuration of the isodynamic curves has been so far sustained by actual survey. We should naturally suppose that the pole of dip and of convergence would be also the pole of intensity; but research shows it to be otherwise, and it is another amongst numerous instances in which Baconian induction has overthrown dreams not founded on experiment. This interesting fact, that these points are separate, was also pointed out by Colonel Sabine.

Plate No. 45.—This plate is intended to show the situation of Porter's Island, the locality at which I found the greatest intensity. The general chart No. 1, will show the general situation of Copper Harbour, on the extreme northern edge of Kewenon peninsula. The lower figure on the plate shows Copper Harbour on a large scale, with Porter's Island, as part of the barrier between the harbour and the lake, just over the words COPPER HARBOUR.

The upper figure represents Porter's Island on a still larger scale, showing the topography and geology. The right hand part marked, "*bare conglomerate rocks*," is composed of imperfectly stratified brown rocks, rising from the lake at an angle of 30°, and overlapping at the words "conglomerate ends," a sandstone changed by heat into a kind of trap rock. At this junction of the rocks a sudden magnetic change is evident, the dip is suddenly increased by a quantity equal to 1° 3′. The several magnetic stations referred to in the text, are here marked by numbers beginning at the extreme west, 1, 2, 3, 4, &c., to 7, at "Magnet Inlet," and 8 and 9, beyond or east of it. At Magnet Inlet the dip, 78° 45′, and the intensity, 1065, are engraved. Here, in passing from station 6 to 7, about 500 feet, the dip increases more than one degree. At the east end of the island is a section of the rocks of which it is composed, enlarged to twice the scale of the Island itself. East of Copper Harbour is a sketch of a copper vein, the spar, including the ore, being about ten feet wide. At a little island east of Porter's, is marked "Metallic Copper." To prevent mistake, it is proper to note that this island is composed of conglomerate rock on which some small pieces of metallic copper have been found. The topography of this harbour is a type of that of the coast for many miles; the upturned edges of the dipping strata throwing the coast into ridges parallel to the shore, and giving an oblong and parallel form to the inlets, bays, harbours, lakes, and islands. The portion marked "Houghton's Lake," is a distinct lake, communicating with the harbour by a river, having several feet of fall. By the side of this river was another magnetic station, and upon the isthmus to the east, still another.

Plate 46.—On this plate are delineated, by the usual means of ordinates, the curves of the dip and of the corresponding total intensity. The delineation has been made upon paper divided into square millimeters; this unit being selected as the least which is easily distinguished. It will be seen, by inspection, that the horizontal distances represent the progress in latitude or longitude, a millimeter to a mile, and that the ordinates, or perpendicular distances, represent the dip, half a millimeter to a minute. The total intensity is represented in still another line, Cincinnati being 1000, and a millimeter being a unit or a thousandth part of the intensity at Cincinnati. As neither the zero of dip nor of intensity come into the scale, the one will be learned at the margin to the right and left; and, the other, by the actual numerical value placed at some one or more of the points along the line.

The most striking circumstance developed by these lines is, that they have a contour apparently determined by the geology of the region over which the line of observation passes. Thus, the line of dip over the horizontally stratified aqueous rocks of the west, through Kentucky and Ohio, and along the Mississippi, are mostly in a gradual ascent, without inversions, while the same line from Baltimore to New York, over igneous rocks, has remarkable fits of ascent and descent, like the contour of primitive or igneous mountains. The line along Lake Superior is still more remarkable in its undulations, and here too are the strongest evidences of igneous action. The observations require to be extended further before a general theory be deduced; but, so far, they go to show that the general nature of subsequent rocks may be ascertained by the magnetic elements; the instruments serving the purpose of the popular notion of a "divining rod." Another fact conspicuously shown by these lines is, that where the dip takes a sudden and anomalous increase, the total intensity shows a correspondent decrease; and the reverse; as at Bristol, Trenton, and New York; slightly at Lexington, Kentucky, and excessively at Porter's Island. The apparent exception is at Isle Royale, where both curves ascend, but this is only apparent, as Isle Royale is quite out of a line between the other places, being further to the north.

Read September 20, 1844.

Medical College of Ohio, Cincinnati, August 13, 1844.

To the American Philosophical Society:—

Since I had the honour of reading before you my paper on Terrestrial Magnetism, I have completed another series of observations, the result of which is herewith communicated to you, in the fascicle for 1844. The paper is hardly a "readable" one, being mostly a table of results expressed chiefly in numbers. Some remarks, however, on local attractions, and the connexion of magnetism with geology and topography, illustrated by a drawing, will, I hope, be found interesting. At any rate, I venture to

request the society to examine the subject so far as to understand the results at which I think I have arrived. Especially am I anxious that they should examine the double siphon curve which represents the magnetic forces along a line traversing a trappean or other pinnacle, capable of becoming feebly magnetic; or, the proposition may be stated, without reference to a figure, as follows. The intensity which ordinarily has a value along a line of moderate length, not varying beyond certain moderate limits, becomes, at the base of a trappean pinnacle extraordinarily diminished, and, at the top of the same, still more extraordinarily increased. This, it will be seen, was decidedly the case at the Palisades of Fort Lee, at Snake Hill, near Bergen, and at Garret Rock of Patterson, New Jersey. I am aware that before this can be admitted as a general law it must be verified in a greater number of instances, and, to draw attention to the settling of the question by the very legitimate method of multiplied observations, is the object of my addressing to you this note on the subject.

JOHN LOCKE.

SERIES FOR 1844.

Cincinnati, March 21, 1844; Latitude 39° 06′, N.; Longitude 84° 22′, W.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
70° 28′	4	*						
	5	1*h*.39*m*.02*s*.8 P	1351.2	46°5	1352.48	1829202.1504	997.67	
	6	3 01 59 6	1345.6	46 5	1347.02	1814947.8400	997.92	
						Mean,	997.79†	1000.23

Locality and geology as previously described.

Cincinnati, July 4, 1844.

70° 25′	4	9*h*.45*m*.59*s*.2 A	1111.59	76°0	1110.43	1233054.7849		
	5	10 10 59 0	1352.4	76 0	1350.90	1824930.8100		
	6	10 40 44 0	1348.0	78 5	1345.80	1811177.6400	1000.	1000.

The above is assumed as the base of this series of observations. The logarithm of the total intensity, in the terms of the horizontal intensity, 3.4747251.

Wheeling, Virginia, Latitude 40° 08′, N.; Longitude, 80° 47′, W.; March 24, 1844.

72°19′20″	4	3*h*.50*m*.01*s*.6 P	1156.0	52°0	1156.6	1337723.56	922.58‡	
	5	4 20 00 8	1410.0	50 5	1410.95	1990779.9025	916.69	1012.9

Observations made in a ravine above the city. Sandstone and shale, of the coal measures, lying nearly horizontally.

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* Some mistake in the observations.

† That at Cincinnati, July 4, 1844, being 1000.

‡ It appears that the needle No. 4 was out of level during almost the whole journey, viz., until June 20, giving an intensity uniformly too high. From a mean of twenty observations a subtractive constant was obtained, the multiplier for which is .00285. Then, 922.58 — 922.58 × .00285 = 919.95, which is still much higher than the indication by No. 5, upon which I rely with so much more confidence that I have excluded the result by No. 4.

Cumberland, Maryland, Latitude 39° 56′, N.; Longitude 78° 47′, W.; March 26, 1844.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
71° 36′	4	3*h*.56*m*.01*s*.6 P	1144.8	69°0	1143.8	1309033.4569	941.95	
	5	4 22 04 4	1395.2	70 0	1394.22	1943849.4084	938.82	
	6	4 50 04 0	1389.2	70 0	1388.65	1928348.8225	939.24	
						Mean,	939.03	996.75

In a ravine. Substratum, sandstone and shale of the coal measures, not horizontal but more or less disturbed by the contiguous up-heaved ridge of the Alleghenies.

Washington, Latitude 38° 53′, N.; Longitude 77° 01′, W.; April 6, 1844; at the Magnetical Observatory, United States Naval Observatory.

71°39′20″	4	1*h*.22*m*.02*s*.0 P	1142.4	53°0	1142.92	1306266.1264	943.05	
	5	1 52 00 0	1391.6	52 0	1392.38	1938722.10644	941.30	
	6	2 26 59 6	1386.0	52 0	1386.97	1923685.7809	941.51	
						Mean,	941.41	1002.58

In the above the reduction of the horizontal intensity by No. 4, by the deduced constant, would give 941.26, quite consistent with the other two needles; still, we have relied on the two Nos. 5 and 6. Geology, drifted gravel and sand, superimposed on gneiss rock in place. It seems that this locality is almost identical with Cincinnati in its total intensity.

Washington, at the old "Depot of Charts and Instruments," near Georgetown, and say one-third of a mile north and a little west of the last station; April 8, 1844.

71°34′48″	4	10*h*.23*m*.00*s*.0 A	1145.60	70°0	1144.86	1310704.4196	939.65	
	5	10 52 01 6	1394.80	72 0	1393.60	1943120.9600	941.99	
	6	11 26 00 0	1389.20	80 0	1388.76	1923103.2976	940.75	
						Mean,	940.72	997.76

Geology, probably identical with that of the preceding.

Washington, at the Capitol Hill, west side of the Capitol, and in a range with the southern end, distant about two hundred feet; April 9, 1844.

71°13′23″	4	7*h*.36*m*.02*s*.4	1138.00	62°0	1138.00	1295044.0000	952.67	
	5	8 04 01 6	1387.60	66 0	1366.97	1923685.7809	948.86	
	6	8 34 05 0	1383.60	71 0	1339.30	1910753.2900	947.88	
						Mean,	948.28	988.22

Washington, Capitol Hill, east side, near the south part of the grounds; April 9, 1844.

71°13′27″	4	6*h*.35*m*.02*s*.0 P	1138.8	63°0	1138.58	1296364.4164	951.16	
							—2.71	
							948.45	987.72

It is presumed, from the situations selected, that they were sufficiently removed from the iron pipes conducting the water through the grounds.

Washington, near the Patent Office, April 10, 1844.

71°14′58″	4	7*h*.21*m*.59*s*.6 A	1141.20	58°	1141.35	1302679.8225	946.55	
	5	7 48 59 6	1390.40	60	1390.40	1933212.1600	943.98	
	6	6 53 01 6	1384.80	56	1385.30	1919056.0900	943.77	
						Mean,	943.88	984.21

In the grounds of the Patent Office, north of its western end.

Washington, between the War Office and the President's house, April 11, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
71°20′30″	4	10*h*.48*m*.01*s*.2 P	1141.20	78° 0	1139.87	1299303.6169	949.71	
	5	11 13 00 0	1390.00	79 00	1388.06	1926710.5636	947.16	
	6	11 46 02 4	1384.80	84 00	1381.88	1909592.3344	948.47	
						Mean,	947.81	993.00

This station, approaching to those of the Observatory and Depot, exhibits a correspondent approach in the elements.

Georgetown, a little east of the point at which High Street crosses the first ridge after leaving the city, in an enclosed wood; April 10, 1844.

71°19′00″	4	1*h*.49*m*.59*s*.6 P	1144.8	75°0	1143.80	1308278.44	943.19	
	5	2 14 03 6	1394.00	73 5	1392.60	1939334.76	941.07	
	6	2 45 00 0	1388.80	75 0	1387.00	1923769.00	941.47	
						Mean,	941.27	984.88

Substratum, a light micaceous, ferruginous soil, superimposed on gneiss rock, extremely prone to disintegration, from a loss of its feldspar.

Mount Vernon, Virginia, Latitude 38° 41′; Longitude 77° 07′; April 11, 1844, about seven hundred feet westward from Washington's tomb.

70°55′30″	4	12*h*.43*m*.03*s*.6 P	1126.80	84°0	1125.04	1265715.0016	974.91	
	5	1 13 01 2	1375.20	86 0	1372.70	1884305.2900	968.49	993.30

Probably the eocene tertiary, superimposed on gneiss. The experiments were made in the shadow of the trunk of a pine tree.

Philadelphia, Latitude 39° 57′, N.; Longitude 75° 10′, W.; April 19, 1844. In the yard of the Magnetical Observatory, near Girard College.

71°59′15″	4	9*h*.52*m*.00*s*.	1158.40	51°0	1158.92	1343095.5664	918.07	
	5	10 28 00 4	1412.00	52 5	1412.74	1995438.7600	914.55	
	6	10 59 01 6	1406.40	55	1407.02	1979311.3344	915.55	
						Mean,	915.05	991.84

The above is an unusual result at Philadelphia, the total intensity having been usually between 993 and 995. I am unable to account for this, unless it has been the result of using a chronometer, the rate of which, in various positions, had not been well determined, my own chronometer having been broken.

Princeton, New Jersey, Latitude 40° 22, N.; Longitude 74° 39′, W.; May 23, 1844; at the usual locality, shown to me by Professor Henry.

72°40′15″	4	4*h*.05*m*.03*s*.2 P	1182.8	77°	1181.5	1395942.25	883.30	993.96

Shale stratified nearly horizontally. This locality is in the open field.

Princeton, second station, Potts's Woods, May 23, 1844.

72°41′25″	5	5*h*.42*m*.01*s*.6 P	1438.4	72°0	1437.2	2065543.84	883.51	994.82

At this station the instruments were more perfectly sheltered from the sun. Geology same as above. Materials believed to be not magnetic.

Princeton, second station, same as above, May 24, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72°41′16″	4	6*h*.47*m*.58*s*.4 A	1180.8	57°	1181.03	1394761.0000	884.06	
	5	7 20 04 4	1439.6	59	1439.70	2072736.0600	880.44	
	6	7 54 04 8	1436.4	61 5	1435.93	2061435.4929	878.60	
						Mean,	879.52	990.53

The above, by reducing the result of No. 4 by the constant .00285, makes 884.06. — 2.52 = 881.51, and including this with the results of Nos. 5 and 6, as above, gives as a mean for total intensity 991.40, instead of 990.53, as above.

Princeton, third station, Rocky Hill, May 24, 1843.

72° 35′	4	11*h*.38*m*.02*s*.8 A	1178.0	78°	1176.7	1384622.89	890.53	997.32

This station is more than a mile from the town, and is at a ridge of trap, rising gradually from the shale below.

New Brunswick, New Jersey, Latitude 40° 30′, N.; Longitude 74° 25′, W.; May 4, 1844; a quarter of a mile south of the city, in a little ravine.

72°43′13″	4	3*h*.34*m*.02*s*. P	1183.2	77° 0	1181.9	1396887.61	882.71	
	5	4 06 03 6	1440.4	77 5	1438.64	2069685.0496	881.69	
	6	4 38 00 0	1435.6	75 5	1433.64	2055323.6496	881.21	
						Mean,	881.45	994.64

I considered the above an unexceptionable locality, and that the elements represented the mean of the neighbourhood. The rock is a shale not far below the surface.

Columbia College, New York City, Latitude 40° 42′, N.; Longitude 74° 01′, W.; April 27, 1844.

72°42′38″	4	12*h*.39*m*.01*s*.2 P	1180.8	55° 0	1181.18	1395186.1924	883.79	
	5	1 06 04 4	1438.4	53 5	1439.05	2070864.9025	881.24	
	6	1 37 04 0	1431.6	50 0	1432.86	2053087.7796	882.12	
						Mean,	881.68	994.35

Diluvial sand, of great depth, superimposed on gneiss.

Asylum for the Insane, near Harlaem, eight miles north of New York; April 26, 1844.

72°41′40″	4	12*h*.52*m*.51*s*.6 P	1182.8	78°5	1181.40	1395705.76	883.46	
	5	1 23 09 2	1441.2	79 0	1439.30	2071584.49	880.93	
	6	1 52 02 0	1436.6	82 0	1433.62	2055266.3044	881.23	
						Mean,	881.08	992.40

Prismatic gneiss rock, near the surface.

Newark, New Jersey, Latitude 40° 43′, N.; Longitude 74° 10′, W.; April 29, 1844; at Mrs. Morris's Garden, in Washington place.

72°50′15″	4	8*h*.21*m*.00*s*.8	1186.8	61°5	1186.80	1408494.24	875.44	
	5	8 52 00 0	1444.4	61 5	1444.40	2086291.360	874.72	
	6	9 25 10 0	1440.4	63 0	1440.00	2073600.0	873.44	
						Mean,	874.08	992.40

Deep alluvium, superimposed on new red sandstone.

Newark, New Jersey, Ward's Woods, on what is called "The Neck;" April 29, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total Intensity, that at Cincinnati being 1000.
72°46′20″	4	3*h*.49*m*.04*s*.4 P	1185.6	80°	1184.06	1401998.0836	879.49	
	5	4 18 04 4	1445.2	77 5	1443.37	2083226.9569	876.01	
	6	4 49 07 0	1438.58	74 5	1436.10	2062383.2100	878.19	
						Mean,	877.10	992.61

Deep marshy soil, with probably sandstone beneath, but at great depth.

Poughkeepsie, New York, Latitude 41° 41′, N.; Longitude 73° 55′, W.; June 13, 1844.

73°57′45″	4	1*h*.21*m*.01*s*.2	1228.8	85°0	1226.8	1505038.24	819.87	
	5	1 53 04 8	1495.2	84 0	1492.3	2226959.2900	819.47	
	6	2 19 00 4	1487.6	84 0	1484.5	2203740.25	819.22	
						Mean,	820.85	995.89

Slate, very much distorted and inclined.

Poughkeepsie, west side of the Hudson, opposite the town; June 13, 1844.

74°12′20″	5	5*h*.05*m*.01*s*.6 P	1492.4	63°0	1492.10	2226362.41	819.70	1009.4

In a ravine, and near to the highest part of the rocks, which are highly inclined and consist of thick beds of sandstone and slate.

Greenbush, opposite Albany, about half a mile east of the village, June 14, 1844; Latitude 43° 39′, N.; Longitude 73° 44′, W.

74°40′36″	4	11*h*.19*m*.01*s*.2 A	1252.00	70°1	1251.08	1565201.1664	781.40	
	5	10 42 02 4	1524.80	70	1523.73	2321753.1129	786.01	
	6	12 00 00 8 P	1518.00	70	1516.66	2300257.5556	787.38	
						Mean,	786.69	997.79

Shale, but covered deep by diluvium.

Albany, New York, Arbor Hill, three-quarters of a mile north-east of the State House; Latitude 42° 39′, N.; Longitude 73° 43′, W.; June 14, 1844.

74°40′10″	4	4*h*.58*m*.03*s*.2 P	1250.80	75°	1249.58	1561450.1764	790.27	
	5	5 28 02 8	1524.00	75	1522.40	2317701.7600	787.38	
	6	6 00 00 0	1518.40	73	1516.67	2300287.8889	787.83	
						Mean,	787.60	998.48

Deep diluvium, of clay and sand.

Utica, New York, Latitude 43° 07′, N.; Longitude 75° 13′, W.; June 16, 1844.

74°48′49″	4	3*h*.57*m*.02*s*.8 P	1251.02	78°0	1249.76	1561900.0576	789.46	
	5	4 39 04 8	1523.60	76 0	1521.09	2316179.6100	787.90	
	6	5 15 01 6	1518.80	76 0	1516.66	2300257.5556	787.38	
						Mean,	787.64	1007.80

Deep alluvium, superimposed on slate. (?) In a meadow half of a mile from the town, not magnetic.

Rochester, New York, Latitude 43° 08′, N.; Longitude 77° 51′, W.; June 17, 1844.

74°38′48″	4	5*h*.02*m*.03*s*.2 P	1246.00	77°	1244.62	1549078.9444	795.79	
	5	6 28 00 0	1516.80	76	1515.11	2295558.3121	794.98	
	6	6 55 02 8	1510.40	65	1509.74	2279314.8676	794.61	
						Mean,	794.79	1006.14

About one and a half miles north, thirty east, from town, in a wood near four very large chestnut trees. Horizontally stratified limestone, not magnetic.

Lockport, Latitude 43° 11′, N.; Longitude 78° 46′, W.; June 18, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total Intensity, that at Cincinnati being 1000.
74°44′12″	4	10*h*.12*m*.01*s*.6 A	1248.00	79°0	1246.46	1553662.5316	993.60	
	5	10 50 04 8	1520.80	83 0	1518.35	2305386.7225	991.55	
	6	11 25 00 0	1516.00	85 0	1512.58	2287898.2564	991.11	
						Mean,	991.33	1007.32

One mile south-east of town, in a wood-land. Horizontal limestone and shale.

Buffalo, June 23, Latitude 42° 53′, N.; Longitude 78° 55′ W.

74°36′30″	4	5*h*.44*m*.01*s*.6 A	1240.50	55°	1240.90	1539832.81	807.72	
							—2.30	
							805.42	1017.01

In a low marshy ground, about thirty rods east of the American Hotel. Lacustrine formation, underlaid by limestone.

Toronto, Upper Canada, Latitude 43° 33′, N.; Longitude 79° 20′, W.; June 19, 1844.

75°12′30″	4	6*h*.26*m*.03*s*.2 P	1258.00	74°	1256.86	1579697.0596	780.56	
	6	6 54 02 0	1526.00	72	1524.92	2325381.0064	—2.62	
							778.94	
							778.87	
						Mean,	778.90	1022.58

These experiments were made in a wood, about one and a half miles east of the Magnetical Observatory. Lacustrine clay and gravel, similar to that of the neighbourhood. I broke the filament of needle No. 5. It will be seen above that No. 4. still reads too high, and its indications are not included in the result. But in the following observations, that needle having been re-levelled, its indications became quite consistent.

Toronto, Upper Canada, June 20, 1844; Magnetical Observatory.

75°13′22″	4	10*h*.43*m*.05*s*.2 A	1259.2	71°	1258.30	1583318.8900	778.77	
	5	11 24 04	1532.4	75	1530.80	2343348.6400	778.77	
	6	12 00 01 2	1528.0	76	1526.00	2328676.0000	777.77	
						Mean,	778.44	1022.95

These observations were made in the little shed where the dip is usually taken. Geology, the same as at the last locality. The only objection to the geology, for a magnetic station, is, that the soil contains rather an abundance of black magnetic sand. In obtaining the above dip, I repeated the observations several times, generally averaging a higher dip, even as high as 17′, but always with some obscurities or inconsistencies, until both needles concurred in the above result; which was, at the same time, consistent with the observations made yesterday, and with a mean of the results of the observatory.

Ashtabula, Ohio, Latitude 41° 52′, N.; Longitude 80° 52′, W.; June 24, 1844.

73°25′03″	4	10*h*.06*m*.00*s*.8 A	1198.8	78°0	1197.40	1433766.76	859.94	
	5	10 34 04 0	1458.8	77 5	1457.06	2123023.8436	860.37	
	6	11 08 24 0	1453.2	79 0	1450.90	2105110.8100	859.59	
						Mean,	859.97	1033.55

Clear, wind north-west. Geology, clay and sand, of the lacustrine formation, superimposed, it is presumed, on the sandstone and shale of the coal formation. Locality, close to the lake, and about twelve hundred feet east of the pier or ship-landing.

Warren, Ohio, Latitude 41° 16′, N.; Longitude 80° 55′, W.; June 25, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total intensity, that at Cincinnati being 1000.
72°55′52″	4	8*h*.53*m*.02*s*.8 A	1184.80	77°5	1183.47	1400601.2409	880.35	
	5	9 22 00 8	1440.70	81 50	1438.59	206951.11881	881.81	
	6	9 56 00 0	1437.60	82 00	1434.84	2058765.8256	879.74	
						Mean,	880.63	1005.60

In a wood, and a little west of the bridge. Alluvium, superimposed on the shale of the coal formation.

Wellsville, Ohio River, Latitude 40° 38′, N.; Longitude 80° 44′, W.; June 26, 1844.

72°35′20″	4	8*h*.16*m*.59*s*.6 A	1196.4	83°0	1194.60	1427069.16	Erroneous.	
	5	9 44 00 0	1432.4	85 0	1429.90	2044614.01	892.55	
	6	10 10 00 4	1427.2	85 0	1424.33	2028715.9489	892.77	
						Mean,	892.66	999.91

On the deep alluvium of the Ohio river, in a dark, shady wood. Surrounding hills, shale and coal.

The following observations were intended expressly to show the effects of local attractions, especially those occasioned by pinnacles of trap rocks.

Snake Hill, near the top, April 30, 1844; Latitude 40° 44′, N.; Longitude 74° 08′, W.

73°12′26″	4	12*h*.47*m*.03*s*.	1194.8	75°	1193.07	1424919.69	865.35	
	6	2 09 05 2	1450.0	78	1447.70	2095835.29	864.18	1002.72

Snake Hill is an outlier of trap about seven miles westward from New York, rising abruptly from the salt marsh which nearly surrounds it. Height, two to three hundred feet. It is a prominent object, and was one of the stations in the coast survey. The local effects are sufficiently apparent. The dip, in unexceptionable situations near, would have been about 72° 45′, and the intensity 993 or 4.

Snake Hill, west side, close to the bottom of the perpendicular rock; April 30, 1844.

72°36′20″	4	4*h*.33*m*.01*s*.2	1183.2	81°0	1181.55	1396060.4025	883.24 —2.52 880.72	987.06

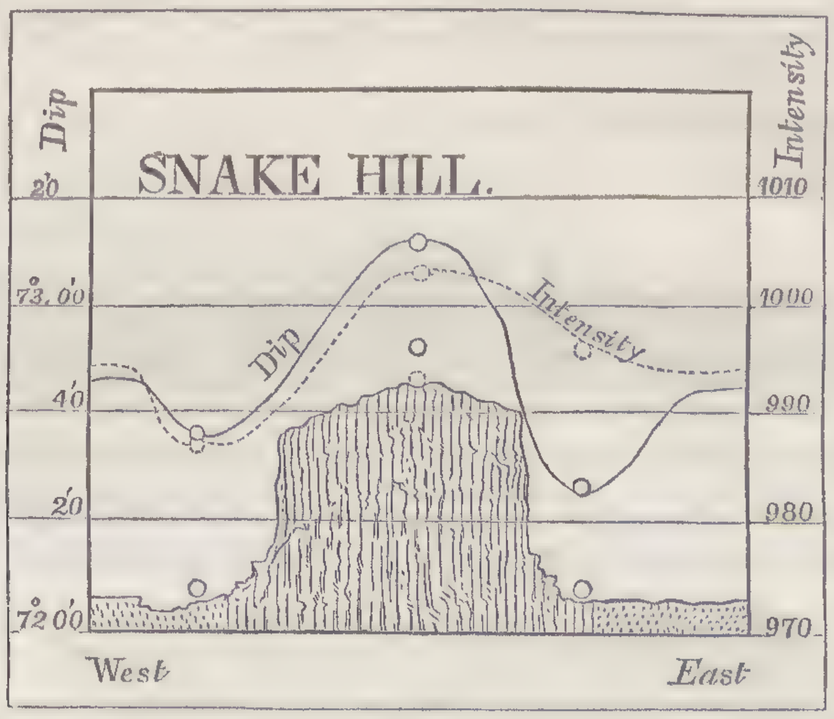
Now if we suppose the vertical trappean hill to be a magnet by terrestrial induction, the upper end must possess an intensity higher than is due to the locality, while the lower end, or bottom of the hill, must exhibit a magnetic force below the same point. In the present case, the mean of the two, the one at the top and the other at the bottom of the hill, viz., 994.88, tallies well with the force or intensity indicated at localities in the neighbourhood, where there is no cause of local disturbance, as at Columbia College, 994.35, or at Princeton, 994.82.

Snake Hill, south-east side, April 30, 1844.

72°27′22″	4	5*h*.50*m*.00*s*.8 P	1172.0	65°0	1171.60	1372446.56	898.43 —2.56 895.87	996.19

This observation was made on the level of the marsh, and a few rods distant from even the talus, or rocks tumbled from the precipice.

The following diagram shows the curves of dip and intensity in traversing Snake Hill from west to east, as indicated by the above results, and by experiments at neighbouring localities.



Fort Lee, about nine miles north of New York, on the west side of the Hudson, May 2, 1844.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72° 28′	4	4*h*.34*m*.02*s*.4 P	1182.2	66°5	1181.7	1396414.89	883.02	982.43

Fort Lee was situated on a promontory which forms the southern termination of the palisades. This promontory has the Hudson river on the east side of it, a ravine and rivulet on the west, and a valley, or recess on the south, in which is situated the village called "Fort Lee."

The palisades are of trap rock, somewhat basaltic or columnar in structure, but presenting rather vertical plates than polygonal columns. Beneath this basalt, at Fort Lee, is a bed of sandstone and shale, lying in a very slight inclination. The valley of the village exhibits a deep deposite of sand and gravel, apparently not magnetic. The station of "the orchard" was of this kind. The above, or station No. 1, was on the ridge of the palisades, about one-third of a mile north of, or above the promontory. The rocks were of trap, scarcely covered with soil, and supporting dwarf cedars and pines.

Fort Lee, Station No. 2, May 3, 1844.

Near the lower end of the promontory, and at the verge overlooking the precipitous descent to the Hudson. With the dipping compass standing on the rocks, the dip read 73° 07′; but when raised up, say three and a half feet on the stand, it read as in the margin below.

72°47′00″	4	6*h*.12*m*.03*s*.6 A	1186.4	65°0	1186.02	1406596.0000	878.00	994.26

Rocks naked, and consisting of massive vertical plates.

Fort Lee, Station No. 3, about forty feet south of No. 2, and on the immediate southern verge of the precipice; May 3, 1844.

72° 51′	4	6*h*.56*m*.02*s*.4 A	1167.6	70°	1166.85	1361538.9225	905.63	1029.82

Fort Lee, Station No. 4, about forty feet from each of the other stations, 2 and 3, westward, forming with them an equilateral triangle.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total intensity, that at Cincinnati being 1000.
	4	10*h*.11*m*.02*s*.4 A	1175.2	81°5	1173.6	1377336.96	895.24	

The dip was not taken at this station, but it appears the horizontal intensity was nearly the same as at No. 3.

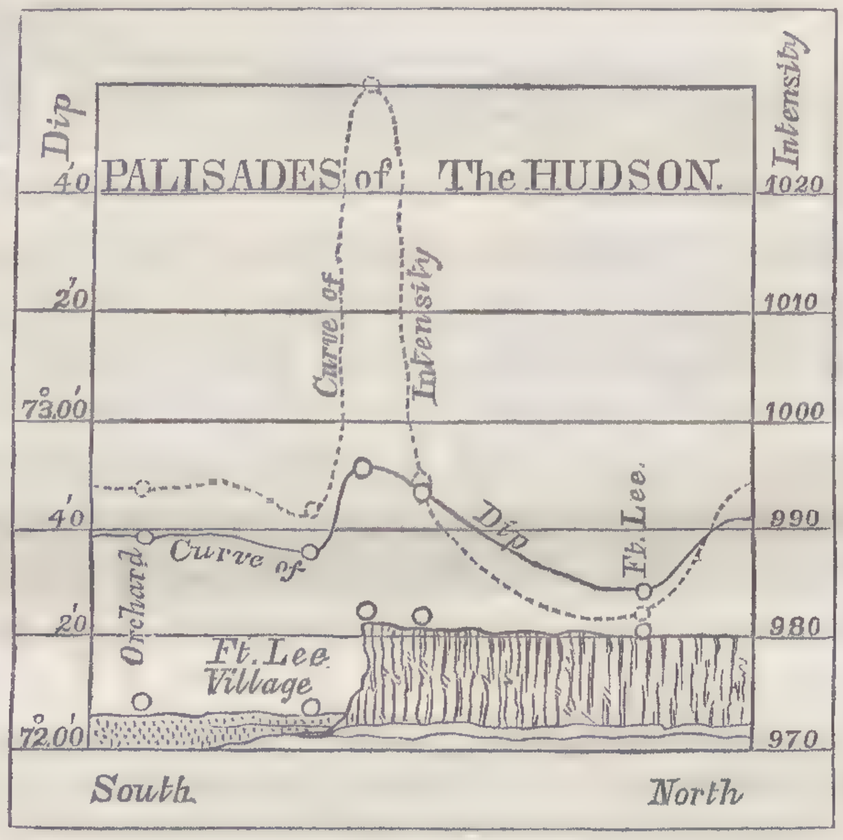
Fort Lee, Station No. 5, at the foot of the promontory, and on the brink of the river, where the sandstone emerges from beneath the trap rock of the Palisades; May 3, 1844.

72° 38′	4	12*h*.10*m*.02*s*.4	1184.4	82°0	1182.67	1398708.3289	881.59	992.24

Fort Lee, Station No. 6, in an orchard, occupying the centre of the recess in which the village has been built. Here the trap rock is wanting, and a deep stratum of drifted sand rests on the subjacent sandstone.

72°39′15″	4	1*h*.57*m*.01*s*.6	1182.4	80°	1180.86	139443033.96	884.27	994.13

The following diagram shows the curves of dip and intensity on traversing the lower precipitous termination of the Palisades from south to north.



Patterson, New Jersey, Latitude 40° 56′, N ; Longitude 74° 10′, W.; June 9, 1844

75°00′30″	4	6*h*.00*m*.01*s*.6 P	1268.00	75°	1260.70	1604680.8976	768.41	995.17

The above result was obtained on Garret Rock, which consists of columnar trap rock, say one hundred and fifty feet high, superimposed on sandstone, nearly horizontally stratified. The station was on the terraced top of the rock, about one hundred feet south of its precipitous northern termination.

Patterson, at the top of the hill of which Garret Rock is a part; June 10, 1844.

73° 55′ 54″	4	Some doubt with regard to the experiment. The probability is, that the quantities were 830.21 and 1005.46. This station was about five hundred yards southwardly from Garret Rock.

Patterson, at the bottom of Garret Rock, and near to the Morris Canal; June 10, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72°17′24″	4	1*h*.13*m*.00*s*.8 P	1171.60	82°00	1169.92	1368712.8064	900.88	992.64

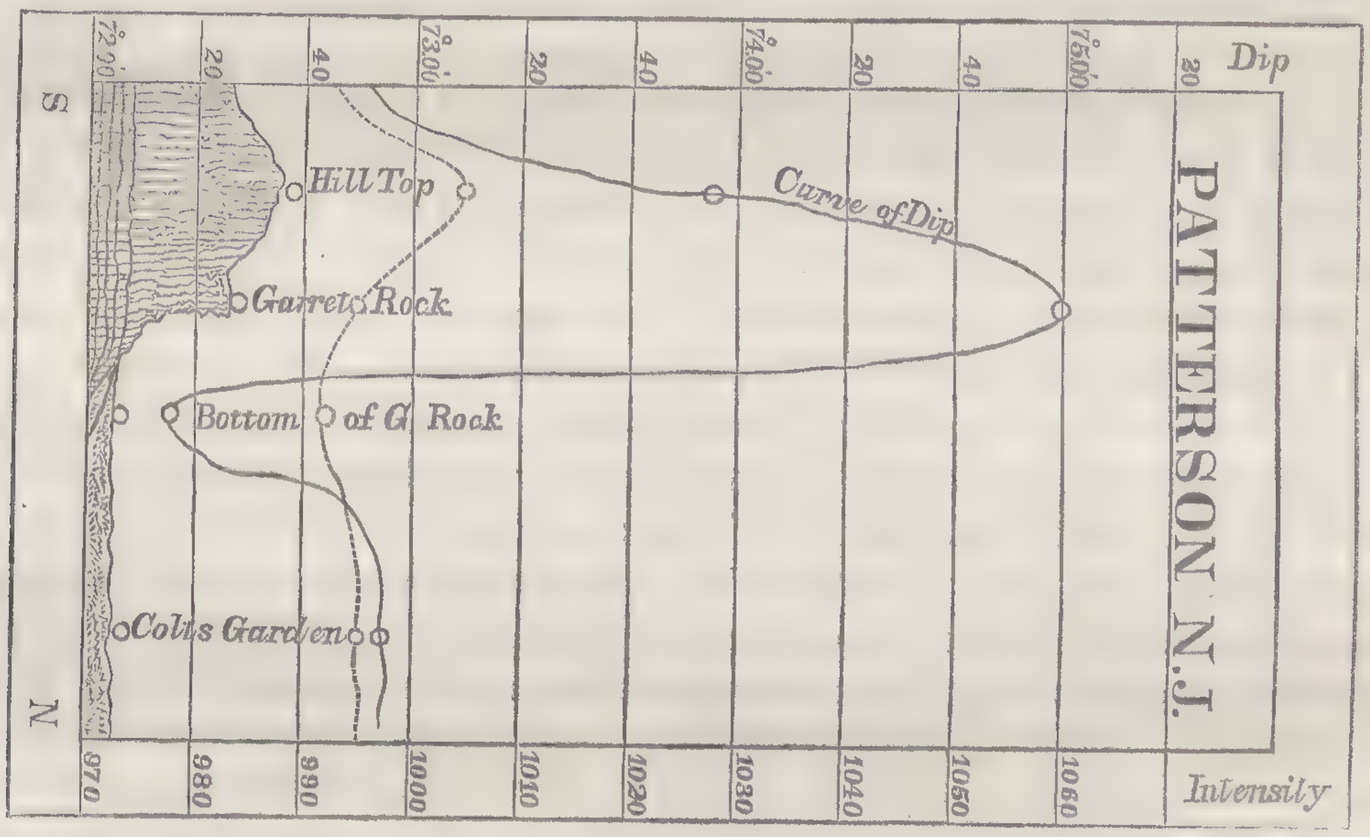
Substratum, sandstone, just below its junction with the superimposed trap rock. The trap of this vicinity is compact, and of a dark colour, entirely destitute of that granular feldspathic structure so apparent in that of Bergen hill.

Patterson, at Mr. R. Colt's Garden, nearly in the centre of the valley in which the town stands.

72°58′06″	4	3*h*.21*m*.03*s*.6 P	1192.0	77°	1190.7	1417766.49	869.71	995.72

This locality, similar to the "orchard," at Fort Lee, may be considered, probably, free from any immediate local attractions, as it is upon a deep substratum of silicious sand, and that again superimposed on sandstone, with no appearance of trappean rocks within half a mile. The distance from Garret Rock is about three-fourths of a mile, in a course a little east of north.

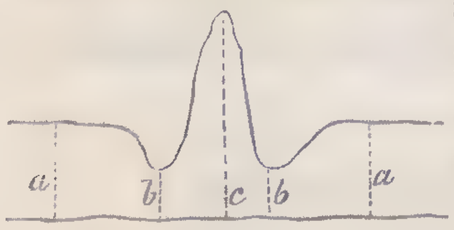
The following diagram shows the curves of dip and intensity in traversing Patterson and Garret Rock from north to south.



REMARKS ON LOCAL ATTRACTIONS.

In the three localities above-named, Snake Hill, Fort Lee, and Patterson, the geology and topography are similar, presenting trappean elevations of moderate height, but having mural or precipitous sides. In the two latter, the trappean mass is superimposed on sandstone, and probably in the first also, but at a depth as yet unexplored. In all of these localities the magnetical elements exhibit the same general phenomena, viz., at the base of the precipice both the dip and the intensity are diminished, but, at the summit,

they are often increased excessively above the mean of the surrounding country, as the dip at Garret Rock, 75° 01′, while the mean dip of the neighbourhood is not over 72° 58′. If we exhibit the dip and intensity, as has been done in a previous paper, by ordinates, on a line passing through the several stations, the curve passing through the superior ends of those ordinates will be of the general form of a double syphon, as shown in the annexed figure, in which the ordinates *a a* represent, say the total intensity of the surrounding country, at unexceptionable localities; *b b* the same at the base of trappean pinnacles, and *c* the same on the pinnacle itself. See the preceding wood-cuts of Snake Hill, Fort Lee, and Patterson, which, as it regards the ordinates, are drawn truly, from actual observations; the horizontal distances and proportional heights in the topographical sketches below the curves, are only generally correct, being drawn without a topographical survey, or a scale of heights and distances. Every magnetician will say, that these phenomena indicate that the trappean pinnacles become magnets by terrestrial induction, diminishing that of the earth at their base, which will be the lower, or north pole, and increasing it at their summits, which will be their upper or south pole. That the dip should be uniformly increased at their summits, must depend on a tendency of the magnetic axis to coincide with the axis of form, which may be considered vertical. Why the dip should be diminished at the base is not so apparent.



There has been some dispute whether the magnetical elements are affected by the altitude of the station. It is most probably the case that they are not affected by mere altitude, as by a balloon, but they may or may not be affected by pinnacles of mountain masses, according to the nature of the materials of which they are composed. My experiments are, so far, a mere step in a long series of labours which are indicated in the research, with regard to local attractions. The immense multiplication of experiments necessary to determine the general laws on the subject is, on the one hand, exciting, as presenting a most interesting field for enterprising research; while, on the other, it is discouraging, especially to a private experimenter, without patronage, and scarcely encouraged by the kind approbation of those amongst whom he is labouring. Not unfrequently he is compelled to suffer all of the distress which neglect, depression, and despondency can inflict. The importance of this kind of investigation is very apparent both in relation to science and to the business of navigation and surveying; for the declination, or variation, is often more affected than even the dip. At Fort Lee the declination changes four degrees in the distance of forty feet; and, at Patterson, on the mountain of Garret Rock, an intelligent surveyor informed me of a change of variation amounting to 32°, in the distance of a few rods. In the midst of disheartening sensations, it was no small encouragement to receive, as an evidence of sympathetic approbation, from a foreign country, the following announcement by Colonel Sabine:—

"*Woolwich*, (*England*,) *April* 2, 1844.

"Dear Sir,—

"I am authorized, by the British Association, to offer you the loan of one of Weber's last improved, transportable magnetometers, if you think it will be useful to you. It is described in Taylor's Scientific Memoirs, vol. ii., Article 8. It determines absolute

declinations, and absolute horizontal intensities, and the variations of both. It will consequently, enable you to make the term observations of declination and horizontal intensity at Cincinnati; as well as to make the absolute determinations which you wish. If you think it will answer your purposes, pray acquaint me how it shall be sent, and where addressed. It is quite ready. Of course, you will understand that you will be free to publish your observations with it wherever you think best,—precisely as if the instrument were your own.

"Believe me, my dear sir, with much respect,

"Very sincerely yours,

"EDWARD SABINE."

Colonel Sabine and the British Association will please accept, through this source, my most cordial acknowledgments both for the honour and favour which they have conferred upon me, and especially for the annexed generous and liberal conditions.

GENERAL SUMMARY.—VII. SERIES, 1844, CINCINNATI TO TORONTO, &c.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total intensity Hor. being 1000.	
88	March 21,	Cincinnati, - - - -	39° 06′	84° 22′	70°28′	997.79	1000.23	That on July 4,1844, being 1000.
89	July 4,	Cincinnati, - - - -	"	"	70 25	1000.00	1000.00	
90	March 24,	Wheeling, Virginia, -	40 08	80 47	72 19 20″	916.69	1012.90	
91	" 26,	Cumberland, Maryland,			71 36 00	939.03	996.75	
92	April 6,	Washington, - - -	38 53	77 01	71 39 20	941.41	1002.58	At the Magnetical Observatory.
93	" 8,	" "	"	"	71 34 48	940.72	997.76	At old Depot, near Georgetown.
94	" 9,	" "			71 13 23	948.28	988.22	West side of the Capitol.
95	" 9,	" "			71 13 27	948.45	987.72	East side of the Capitol.
96	" 10,	" "			71 14 58	943.88	984.21	Near the Patent Office.
97	" 11,	" "			71 20 30	947.81	993.00	Near the War Office.
98	" 10,	Georgetown, - - -	38 53	77 03	71 19 00	941.27	984.88	
99	" 11,	Mount Vernon, - - -	38 41	77 07	70 55 30	968.49	993.30	Near Washington's tomb.
100	" 19,	Philadelphia, - - -	39 57	75 10	71 59 15	915.05	991.84	
101	May 23,	Princeton, New Jersey,	40 22	74 39	72 40 15	883.30	993.96	Usual station.
102	" 23,	" "			72 41 25	883.51	994.82	Potts's Woods.
103	" 24,	" "	40 22	74 39	72 41 15	879.52	990.53	" "
104	" 24,	" "	40 23	74 39	72 35 00	890.53	997.32	Rocky hill. Trappean.
105	" 24,	New Brunswick, - -	40 30	74 25	72 43 13	881.45	994.64	
106	April 27,	Columbia College, - -	40 42	74 01	72 42 38	881.68	994.35	
107	" 26,	Harlaem, - - - - -	40 49	74 01	72 41 40	881.08	992.40	
108	" 29,	Newark, New Jersey,	40 43	74 10	72 50 15	874.08	992.40	"Washington Place."
109	" 29,	" "	40 43	74 09	72 46 20	877.10	992.61	On the "Neck."
110	June 13,	Poughkeepsie, N. Y., -	41 41	73 55	73 57 45	820.85	995.89	
111	" 13,	Opposite Poughkeepsie,	41 41	73 56	74 12 20	819.70	1009.40	
112	" 14,	Greenbush, New York,	43 39	73 44	74 43 06	786.69	997.79	
113	" 14,	Albany, New York, -	42 39	73 45	74 40 10	787.60	998.48	
114	" 16,	Utica, New York, - -	43 07	75 13	74 48 49	787.64	1007.80	
115	" 17,	Rochester, New York,	43 08	77 51	74 38 48	794.79	1006.14	
116	" 18,	Lockport, New York, -	43 11	78 46	74 44 12	991.33	1007.32	
117	" 23,	Buffalo, New York, -	42 53	78 55	74 36 30	805.42	1017.01	
118	" 19,	Toronto, Upper Canada,	43 33	79 19	75 12 30	778.90	1022.00	Woods 1½ miles E. of Observat'y.
119	" 20,	" "	"	79 20	75 13 22	778.44	1022.95	Observatory.
120	" 24,	Ashtabula, Ohio, - -	41 52	80 52	73 25 03	859.97	1033.55	Close to the lake.
121	" 25,	Warren, - - - - - -	41 16	80 55	72 55 52	880.63	1005.60	
122	" 26,	Wellsville, - - - -	40 38	80 44	72 35 20	892.66	999.91	Ohio river.

THE FOLLOWING OBSERVATIONS WERE MADE EXPRESSLY TO DETERMINE SOME OF THE LAWS OF LOCAL ATTRACTION:—

123	April 30,	Snake Hill, - - - -	40° 43′	74° 06′	73°12′26″	864.18	1002.72	Top of the hill. Trappean.
124	" "	" "			72 36 20	880.72	987.06	Bottom, west side.
125	" "	" "			72 27 22	895.87	996.19	Bottom, east side.
126	May 2,	Fort Lee, New York, -	40 51	74 01	72 28 00	883.02	982.43	North part of Hill, station 1.
127	" 3,	" "			72 47 00	878.00	994.26	South promontory, top, 2.
128	" "	" "			72 51 00	905.63	1029.82	Top, extreme verge, 3.
129	" "	" "			Not taken.	895.24		Station 4.
130	" "	" "			72 38 00	881.59	992.24	Bottom of hill,& brink of Hudson.
131	" "	" "			72 39 15	884.27	994.13	In a sandy plain, ½ mile from hill.
132	June 9,	Patterson, New Jersey,	40 56	74 10	75 00 30	768.41	995.17	Top of Garret Rock. Trap.
133	" 10,	" "			73 55 54	830.21	1005.46	Top of trap hill.
134	" "	" "			72 17 24	900.88	992.64	Bottom of hill of trap.
135	" "	" "			72 58	869.71	995.72	In a sandy area—no trap.

ERRATA IN THE PRECEDING PAPER.

Page 286, last line, for "recorded," read *reckoned.*

" 291, eighth line from the bottom, for "bluff or cliff limestone," read *bluff of cliff limestone.*

" 293, about the middle of the page, for "chest," read *chert.*

" 294, in "23. Dayton, Ohio," seventh column of the table, the decimal point is one place too far to the right, thus: for "9511," read 951.1, and so down the column: and in the eighth column of the same table, for "298.71," read 2987.1.

" 307, in the fourth column of table 78, for "138.0," read 1380.

" 309, twenty-second line from top, for "temperature," read *intensity.*

" 309, table at bottom of the page, heading of 9th column, for "horizontal intensity," read *Total intensity that at Cincinnati being* 1000.

" 311, fifteenth line from bottom, for "as follows," read *as above.*

" 315, twenty-second line from top, for "subsequent," read *subjacent.*

" 316, 317, and 318, in the heading of the ninth or last column of the tables, for "Total intensity, horizontal being 1000," read *Total intensity, that at Cincinnati being* 1000.

ARTICLE XII.

Observations of the Magnetic Dip, made at several positions, chiefly on the south-western and north-eastern frontiers of the United States, and of the Magnetic Declination at two positions on the River Sabine; in 1840. *By Major James D. Graham, of the United States' corps of Topographical Engineers. Read* 16*th August*, 1844.

The observations of the magnetic dip and declination, from the 29th of January to the 5th of June, 1840, contained in this paper, were made while I was attached to the joint commission for the demarcation of that portion of the boundary, between the United States and Texas, included between the mouth of the river Sabine and its intersection with the thirty-second degree of north latitude.

The observations for the dip, subsequent to that period, were made while I was serving as a commissioner, on the part of the United States, for the survey and exploration of the territory then in dispute with the government of Great Britain, upon our north-eastern frontier. The only apparatus in possession of the Commission for the demarcation of the boundary between the United States and Texas, that could be applied to the determination of the declination or horizontal variation of the magnetic needle, consisted of the surveyor's compasses furnished for the survey, and the needle of a theodolite. Although a good variation transit would have been preferred for this purpose, yet the want of such an instrument was, in a great measure, compensated for, by the use of three different needles instead of one. These were observed upon, with the poles direct, and then again, with the poles reversed. In every instance, the errors of the instruments were compensated, as far as practicable, by noting the readings of both ends of the needles, and by reversing the direction of the vanes of the compasses, and then making another set of readings in the same manner. When the theodolite needle was observed upon, both ends were read before, and then again, after a reversal, by a horizontal motion of the azimuth plate; and a mean of all the separate results was adopted, for the correct declination, at each station.

The observations for the magnetic dip were made with an instrument constructed by Troughton & Simms, of London, in the year 1838. It was obtained for the Commission for the Texan boundary survey, from Messrs. William Bond & Son, of Boston, for

whom it was made. The whole instrument is of brass. The azimuth circle is divided by the aid of a vernier to read to minutes. The vertical or dip circle is eight inches in diameter, divided, on a silver-washed surface, to read to fifteen minutes of arc. But, by the aid of a magnifying lens, the readings may easily be estimated to the nearest two minutes.

In the centre of the dip circle are two polished semi-cylindrical agate supports for the axis of the needle to rest upon. The central position of the needle is adjusted by two brass Y's, which can be raised or lowered, when necessary, to relieve the axis of the needle from the agates, or to adjust its bearing upon them. They also serve to shorten the vibrations of the needles, in order to diminish the time necessary for the readings. The instrument was supplied with two needles, each $7\frac{85}{100}$ inches long. The one designated as needle No. 1, is a parallelogram in shape, with rounded ends, marked by a fine line at each end, to indicate the centre of form. The other, designated as needle No. 2, is of the acute lozenge shape. The axes of these needles are of nicely polished steel. The box in which the instrument is packed is furnished with a pair of bar magnets, for reversing the poles of the needles; a magnifying lens, with a silvered reflector, for reading the angles; and the necessary adjusting tools. There is also a needle, three inches long, in a rectangular brass box, with a glass cover, with fixtures for attaching it upon the azimuth plate, parallel to the plane of the dip circle, for the purpose of bringing the latter to coincide with the magnetic meridian. When this is done, this small needle is removed. There are two short, but delicate, spirit-levels attached, at right angles to one another, to the moveable azimuth plate. These are levelled by three foot-screws, which support the instrument upon its stand. The needles are protected from the action of the wind by a glass cover, placed over the vertical or dip circle, the side next to the graduated face being readily opened for the necessary arrangements of the needles, reversing them on their axes, &c.

The needles are marked, upon one of the flat sides, and near one end, with the figures 1 and 2, respectively. This simple mark upon each needle serves to designate its number, its face, and its magnetic state. It is sufficient to refer to this number to designate the needle observed upon, and all the changes of position of which it is susceptible. In making the observations, the following method was always pursued; namely,—Both ends of the needle were read, with the face of the dip circle to the east, and also to the west, and with the face or marked side of the needle twice to the east and twice to the west; that is, once each way, by a change of direction of the face of the instrument, and once each way, again, by a reversal of the needle on its axis. A mean of all the readings was then taken and noted. The poles of the needle were then changed, and the same course repeated, and a mean of all the readings noted. A mean of these two results was taken, for the dip indicated by the needle. The same operation was then performed with the other needle, and a mean of the final results of the two needles was adopted as the magnetic dip for the station. Care was always taken, in selecting positions for observation, both for the dip and the declination, to have them beyond the reach of influence upon the needles, arising from the iron in buildings, or from any other local cause. The magnets—all iron or steel in the shape of keys, penknives, the cooking utensils belonging to the camp, &c.—were always kept remote from the instrument during the observations,

and were always sent in a direction east or west (magnetic) of the instrument, in order thus to neutralize all influence upon the needles.

The close coincidence in the results of the two dipping needles which was still exhibited, after the accident by lightning, to needle No. 2, described hereafter, will serve as a striking illustration of the importance of the several reversals, of the face of the instrument, of the face of the needles, by turning their axes end for end, and of the poles. Previous to that accident, the indications by needle No. 2, were quite as uniform throughout its various positions, as those by needle No. 1. After the accident, needle No. 2 always exhibited a variation in its extreme indications, arising from change of position, amounting to ten, and, sometimes, to nearly twelve degrees!! Still, the mean of all the observations made, in the manner described, seems to have agreed as well, or nearly as well, as before the accident, with the dip indicated by needle No. 1, which always remained in good order.

The absolute error of needle No. 2, seems to have been constant, or very nearly so, but by the several reversals of position, and of the poles, this error was rendered as often *positive* in its character as it was *negative*, and was thus neutralized, or very nearly so. In order to show the characters of the two needles in the various positions necessary for a course of observations, both before and after the accident to No. 2, all the readings are given for two sets of observations by each needle, both prior to and subsequent to that period; namely, for the stations at the light-house of the south-west pass of the Mississippi, and the mouth of the River Sabine, where observations were made before that accident, and for Gaines' Ferry, in Texas, and West Point, New York, where observations were made after the accident. It was at this last-mentioned position that needle No. 2 was observed upon, for the last time, on the 24th of August, 1840.

Its place was afterwards substituted by two other needles, marked No. 3 and 4. They were made expressly for me, by Mr. J. N. Baur, of New York, and are of the acute lozenge shape, very similar, in form, to No. 2.

In order to show the characters of the two new needles, it has been thought important to give a full set of observations by each of them. These are exhibited in the first observations that were made with them, immediately after they were magnetized; namely, for the station 4578 feet directly north from the monument erected to designate the source of the river St. Croix, under the fifth article of the treaty of 1794. They will be found under the dates of October 18th and 20th, 1840.

The needles were always charged as strongly as practicable, and generally to saturation, both when the poles were direct and also when reversed. This is an important object in observing the dip, for the stronger the needles are charged with magnetism, the less is the effect of any want of perfect balance, or any imperceptible dust or other particles that may adhere to them, to deflect them from the true angle of dip.

The localities occupied by the instrument, at the several stations, have been minutely described, in order that they may be easily found by future observers, and that an exact comparison of results may be made, and the change of dip, with the lapse of time, be the more accurately ascertained.

J. D. GRAHAM, Maj. Top. Engineers.

I. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE, WITH INSTRUMENT BY TROUGHTON AND SIMMS, OF LONDON.

Date and place of observation.—1840, January 29th. At the Light-House, South-West pass, mouth of Mississippi River. Latitude 28° 58′ 50″, N.; Longitude 89° 21′ 27″, W.

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. | Mins. & Tenths.	South end of Needle reads Deg. | Mins. & Tenths.	Mean of both ends of needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	11.00 A.M.	59 . 08 . 0	58 . 48 . 0	58 . 58 . 0	67°	J.D.G.
"	"	W	W	" "	58 . 00 . 0	58 . 20 . 0	58 . 10 . 0		
"	"	W	E	" "	58 . 50 . 0	59 . 12 . 0	59 . 01 . 0		
"	"	E	W	" "	58 . 52 . 0	58 . 30 . 0	58 . 41 . 0		
1	S	E	E	2.40 P. M.	58 . 52 . 0	58 . 40 . 0	58 46 . 0		J.D.G.
"	"	W	W		58 . 30 . 0	58 . 42 . 0	58 . 36 . 0		
"	"	W	E	4.05	57 . 15 . 0	57 . 35 . 0	57 . 25 . 0		
"	"	E	W	4.05	60 . 52 . 0	60 . 15 . 0	60 . 33 . 5		

Needle No. 1, with marked end north, gives . . . . . 58° 42′.5
Needle No. 1, with marked end south, gives . . . . . 58 50 .12
Dip, by sixteen observations on needle No. 1, ... 58 46 .3

2	S	W	W	4.30 P. M.	57 . 40 . 0	57 . 15 . 0	57 . 27 . 5	66°	J.D.G.
"	"	E	E		58 . 30 . 0	58 . 35 . 0	58 . 32 . 5		
"	"	E	W		57 . 10 . 0	57 . 35 . 0	57 . 22 . 5		
"	"	W	E		58 . 30 . 0	58 . 17 . 0	58 . 23 . 5		
2	N	W	W		58 . 35 . 0	58 . 15 . 0	58 . 25 . 0		J.D.G.
"	"	E	E		59 . 35 . 0	59 . 30 . 0	59 . 32 . 5		
"	"	E	W		59 . 45 . 0	59 · 23 . 0	59 . 34 . 0		
"	"	W	E		59 . 57 . 0	59 . 40 . 0	59 . 48 . 5		

Needle No. 2, gives, with marked end north, ... 59° 20′
With marked end south, ... 57 56 .5
Dip, by sixteen observations on needle No. 2, ... 58 38 .25
Dip, by sixteen observations on needle No. 1, ... 58 46 .3
Magnetic dip, at the Light-House of the South-West pass of the Mississippi, by a mean thirty-two observations on both needles, ... 58° 42′.25

NOTE.—The position chosen for the observations was about four hundred feet south-east of the new light-house, on Backus Island, which had been finished within a few days previous to these observations.

II. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE.

Date and place of observation.—1840, February 11th, at Dr. Everett's house, west bank of Sabine River, near its entrance into the sea; Texas. Latitude 29° 43′ 54″, N.; Longitude 93° 51′ 30″, west of Greenwich.

NOTE —The point of observation of the magnetic dip bears, compared with the true meridian, north by west, $\frac{3}{4}$ P. W., and is distant $3\frac{23}{100}$ miles from mound A, which marks the western shore of the mouth of the river Sabine, in the maps showing the demarcation of the boundary between the United States and Texas.

1	S	W	W	11.35 A. M.	59 . 15 . 0	59 . 00 . 0	59 . 07 . 5		
"	"	E	E	0.25 P. M.	57 . 25 . 0	57 . 37 . 0	57 . 31 . 0		
"	"	E	W	0.50	59 . 00 . 0	59 . 15 . 0	59 . 07 . 5		
"	"	W	E	1.20	58 . 20 . 0	58 . 05 . 0	58 . 12 . 5		

No. of Needle.	Polarity of marked end of needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads. Deg. | Mins. & Tenths.	South end of Needle reads. Deg. | Mins. & Tenths.	Mean of both ends of Needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	2.0 P.M.	59 . 37 . 0	59 . 20 . 0	59 . 28 . 5		
"	"	W	W	2.45	57 . 38 . 0	58 . 05 . 0	57 . 51 . 5		
"	"	W	E	3.10	59 . 00 . 0	59 . 18 . 0	59 . 09		
"	"	E	W	3.25	58 . 15 . 0	58 . 00 . 0	58 . 07 . 5		

Needle No. 1, with marked end south, gives . . . . . 58° 29′.6
Needle No. 1, with marked end north, gives . . . . . 58 39 .1
Dip, by sixteen observations on needle No. 1, ... 58 34 .3
Clear, pleasant weather all day. Pleasant breeze from south-east. Air humid.

February 12th, at Dr. Everett's house.

2	N	E	E	10.20 A.M.	59 . 28 . 0	59 . 03 . 0	59 . 15 . 5		
"	"	W	W	10.55	59 . 17 . 0	59 . 45 . 0	59 . 31 . 0		
"	"	W	E	11.30	58 . 22 . 0	58 . 37 . 0	58 . 29 . 5		
"	"	E	W	11.55	59 . 30 . 0	59 . 15 . 0	59 . 22 . 5		
2	S	W	W	3.12 P.M.	57 . 25 . 0	57 . 00 . 0	57 . 12 . 5		
"	"	E	E	3.40	58 . 33 . 0	59 . 03 . 0	58 . 48 . 0		
"	"	E	W		57 . 10 . 0	57 . 25 . 0	57 . 17 . 5		
"	"	W	E		58 . 33 . 0	58 . 22 . 0	58 . 27 . 5		

Needle No. 2 gives, with marked end north, ... 59° 09′.6
With marked end south, ... 57 56 .4
Dip, by sixteen observations on needle No. 2, ... 58 33
Dip, by sixteen observations on needle No. 1, ... 58 34 .3
Magnetic dip at Dr. Everett's house, near the mouth of the river Sabine, by a mean of thirty-two observations, on both needles, ... 58° 33′.65

February 17th, 1840. At Dr. Everett's house, west shore of the river Sabine, near its entrance into the sea, Texas; Latitude 29° 43′ 54″, N.; Longitude 93° 51′ 30″, west of Greenwich.

This night the star Polaris (α Ursæ Minoris) was observed upon at its greatest western elongation, in order to obtain the true meridian direction, to be used in observing the variation of the magnetic needle.

The observation was made with a good transit theodolite, (marked No. 2) by E. Draper, of Philadelphia. To avoid any error in transferring the azimuthal direction of the star while at its point of greatest elongation, to the surface of the ground, an artificial horizon of quicksilver was used, and the azimuth-plate of the theodolite was so adjusted, by the levelling screws, as to cause the vertical wire to bisect the star and its reflected image by a vertical sweep of the telescope, made a few seconds before the time of greatest elongation.

When the observation on the star was completed, the telescope was carefully brought to a horizontal position, and a lantern was placed upon the ground at a distance of one hundred and forty yards to the north, and so adjusted in position as to be bisected by the vertical wire. A stake was driven firmly into the ground to mark this point, and another to mark the position of the centre of the theodolite. Next morning, (February 18th,) the theodolite was adjusted carefully in its former position, and an angle of 1° 46′ 15″,

(the computed azimuth of the star when observed upon,) was laid off to the east of the stake driven on the night of the 17th, by taking a mean of the readings of three verniers, each reading to fifteen seconds. This new direction, being that of the true meridian, was marked by two permanent stakes, three hundred and seventy five yards apart, the one being to the north, and the other to the south of the position occupied by the theodolite.

These stakes were to be permanent marks, while this station was occupied, for use in observing the horizontal declination of the needles.

February 18th. This night the star Polaris was again observed, when at its greatest western elongation, for the purpose of verifying the accuracy of the azimuth direction obtained by the observation of the 17th. The same means were adopted as before described, and the direction of the azimuth line corresponded with that obtained by the previous observation.

February 19th, 1840. At Dr. Everett's house, west shore of Sabine river, near its entrance into the sea; Texas. Latitude 29° 43′ 54″, N.; Longitude 93° 51′ 30″, W.

III. Magnetic bearing of the true meridian line, to ascertain the variation or horizontal declination of the needle. (Same station as II.)

First, by compass No. 3, by W. J. Young, of Philadelphia, needle six inches long. At 2*h.* 00*m.*, P. M.

Vane A of Compass to the north,—

North end of needle gives the variation,	8° 37′ East.
South end of needle gives,	8° 36′
The end of the needle at 0, the compass vernier gives,	8° 35′

Vane A of compass to the south,—

North end of needle reads,	8° 32′
South end of needle reads,	8° 33′
Compass vernier reads, (with end of needle at 0,)	8° 35′

Reversed the poles of the needle by bar magnets, when the readings were as follows: At 5*h.* 30*m.*, P. M. Vane A of compass to the north,—

North end of needle reads,	8° 44′ East.
South end of needle reads,	8° 44′
Compass vernier reads, (with the end of needle at 0,)	8° 42′

Vane A of compass to the south,—

North end of needle reads,	8° 45′
South end of needle reads,	8° 45′
Compass vernier reads, (with the end of needle at 0,)	8° 45′
Result, by needle of compass No. 3, with poles direct,	8° 34′.66
with poles reversed,	8° 44′.16
Variation of the needle of compass No. 3, by a mean of twelve observations upon it,	8° 39′.4 E.

Second, by compass No. 4, by W. J. Young, of Philadelphia, needle five and a quarter inches long. At 1*h*. 32*m*., P. M.

Vane A of compass to the north,—

North end of needle reads,	8° 42′ East.
South end of needle reads,	8° 43′
Compass vernier reads, (with end of needle at 0,)	8° 43′

Vane A of compass to the south,—

North end of needle reads,	8° 42′
South end of needle reads,	8° 42′
Compass vernier reads, (with end of needle at 0,)	8° 42′

Reversed the poles of the needle by means of bar magnets, when the readings were as follow. At 6*h*. 00*m*., P. M.:

Vane A of compass to the north,—

North end of needle reads,	8° 50′ East.
South end of needle reads,	8° 50′
Compass vernier, with end of needle at 0, reads,	8° 47′

Vane A of compass to the south,—

North end of needle reads,	8° 47′
South end of needle reads,	8° 45′
Compass vernier, (with end of needle at 0,) reads,	8° 46′
Result, by needle of compass No. 4, with poles direct,	8° 42′.33
with poles reversed,	8° 47′.5
Variation of needle of compass No. 4, by a mean of twelve observations upon it,	8° 44′.9

Third, by a small theodolite, by E. Draper, Philadelphia. Needle four and a half inches long.

At 3, P. M., north end of needle reads,	8° 34′ East.
south end of needle reads,	8° 38′
North end of needle being at 0, vernier reads,	8° 34′
South end of needle being at 0, vernier reads,	8° 38′.5
Variation of needle of small theodolite by a mean of four readings,	8° 36′.1 E.

This needle could not be conveniently taken out of the box, and therefore its poles were not reversed.

SUMMARY.

1st. Magnetic variation by twelve observations on needle of compass No. 3,	8° 39′.4
2d. " " by twelve observations on needle of compass No. 4,	8° 44′.9
3d. " " by four observations on the needle of the theodolite,	8° 36′.1
Magnetic variation at Dr. Everett's house, near the entrance of the river Sabine into the sea, by a mean of twenty-eight observations on three needles, February 19th, 1840,	8° 40′.1 E.

February 28, 1840. Observations on the dip of the magnetic needle, repeated at Dr. Everett's house, west bank of the river Sabine. Same station as II., occupied on the 11th and 12th of February. Latitude 29° 43′ 54″, N.; Longitude 93° 51′ 30″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Dip observed.
N	8	11*h*. 33*m*. A.M.	58° 49′.6
S	8	1 23 P.M.	58° 22′.4

Dip, by sixteen readings of needle No. 1, ... 58° 36′

NEEDLE No. 2.

S	8	3*h*. 36*m*. P.M.	57° 49′.2
N	8	4 28 "	59° 07′.4

Dip, by sixteen readings of needle No. 2, ... 58° 28′.3
Dip, by sixteen readings of needle No. 1, as above, 58° 36
Dip, by a mean result from needles No. 1 and No. 2, 58° 32′.1

Differing only 1′.5 from the result obtained from the same needles, at this station on the 11th and 12th of February, 1840.

A light south wind all day. The weather a little cloudy from sunrise till 1, P.M., when it was clear and nearly calm till sunset.

February 29th, 1840, at Dr. Everett's house, west shore of the Sabine River, near its entrance into the sea; Texas. Latitude 29° 43′ 54″, N.; Longitude 93° 51′ 30″, W. Same station as II.

IV. Observations for the magnetic variation were this day repeated at the same station which was occupied on the 19th instant, the magnetic bearing of the true meridian line was as follows, viz.:

First, by compass No. 3, by W. J. Young, of Philadelphia, needle six inches long. At 11*h*., A.M. Vane A of compass to the north,—

North end of needle reads, ...	8° 43′ East.
South end of needle reads, ...	8° 40′
Compass vernier, with end of needle at 0, reads, ...	8° 43′

Vane A of compass to the south,—

11*h*. 10*m*., A.M., north end of needle reads, ...	8° 45′
South end of needle reads, ...	8° 45′
Compass vernier, (with the end of the needle at 0,) reads, ...	8° 42′

Mean of the six readings of compass No. 3, with poles reversed, or, as left on the 19th instant, ... 8° 43′ East.

Second, by compass No. 4, by W. J. Young, Philadelphia, needle five and a quarter inches long. At 11*h*. 30*m*. A.M. Vane A of compass to the north,—

North end of needle reads, ...	8° 45′ East.
South end of needle reads, ...	8° 45′
Compass vernier, (with the end of the needle at 0,) reads, ...	8° 45′

11*h.* 40*m.*, A.M., vane A of compass to the south,—
North end of needle reads, ... 8° 46′ East.
South end of needle reads, ... 8° 47′
Compass vernier, with needle at 0, reads, ... 8° 47′
Mean of these six readings of compass No. 4, with poles reversed, or, as left on the 19th instant, ... 8° 45′.8

Changed the poles of the needles of both compasses, by means of the bar magnets, thus making them direct again, when the readings were as follows, viz.:

Third, by compass No. 3. At 0*h.* 50*m.* P.M. Vane A of compass to the north,—
North end of needle reads, ... 8° 40′ East.
South end of needle reads, ... 8° 38′
Compass vernier, (with the end of needle at 0,) reads, ... 8° 40′
1*h.* 00*m.*, P.M, vane A of compass to the south,—
North end of needle reads, ... 8° 38′
South end of needle reads, ... 8° 40′
Compass vernier, (with the end of needle at 0,) reads, ... 8° 38′
Mean of six observations on compass No. 3, with poles of the needle direct, 8° 39′
" " " " " with poles reversed, ... 8° 43′
Variation of needle of compass No. 3, by a mean of twelve observations upon it, ... 8° 41′

Fourth, by compass No. 4, at 1*h.* 07*m.*, P.M. Vane A of the compass to the north,—
North end of needle reads, ... 8° 45′ East.
South end of needle reads, ... 8° 45′
Compass vernier, (with the end of needle at 0,) reads, ... 8° 45′
Vane A of compass to the south,
North end of needle reads, ... 8° 45′
South end of needle reads, ... 8° 45′
Compass vernier, (with end of needle at 0,) reads, ... 8° 45′
Mean of six observations on compass No. 4, with poles direct, ... 8° 45′ East.
" " " " " with poles reversed, ... 8° 45′.8
Variation of needle of compass No. 4, by a mean of twelve observations upon it, ... 8° 45′.4 East.

Fifth, by the small theodolite by E. Draper, of Philadelphia. Needle four and a half inches long. End A of needle-box to the north.
At 4*h.* 10*m.*, P.M.—North end of needle reads, ... 8° 32′ East.
South end of needle reads, ... 8° 34′
End A of needle at 0, vernier reads, ... 8° 34′
Revolved the instrument 180° in azimuth, bringing end A of needle-box to the south.
4*h.* 30*m.* P.M.—North end of needle reads, ... 8° 35′
South end of needle reads, ... 8° 36′
End A of needle at 0, vernier reads, ... 8° 37′

Mean of these six readings of the needle of the small theodolite, with the poles direct, ... 8° 34′.6 E.

Sixth, by the same instrument, the poles of the needle having been reversed.

At 5*h*. 15*m*., P. M., end A of compass box to the north,—

North end of needle reads, ... 8° 35′ East.
South end of needle reads, ... 8° 35′
South end of needle at 0, vernier reads, ... 8° 34′

Mean of these six readings of small theodolite, with the poles of the needle reversed, ... 8° 34′.8 E.

Mean of six readings of small theodolite with poles direct, ... 8° 34′.6

Variation of theodolite needle by a mean of twelve observations upon it, . 8° 34′.7 E.

SUMMARY.

1. Magnetic variation, by twelve observations on needle of compass No. 3, six inches long, ... 8° 41′ East.
2. Magnetic variation, by twelve observations on the needle of compass No. 4, five and a quarter inches long . . . . . 8° 45′.4
3. Magnetic variation by twelve observations on the needle of the theodolite, four and a half inches long, ... 8° 34′.7

Magnetic variation at Dr. Everett's house, near the entrance of the river Sabine into the sea, in latitude 29° 43′ 54″, N.; longitude 93° 51′ 30″, W.; by a mean of thirty-six observations on three needles February 29, 1840, 8° 40′.3 E.

This day was clear, with flying clouds, and a moderate breeze from south south-east; the atmosphere tolerably dry.

Remark.—It will be observed that the variation of the theodolite needle was scarcely affected by reversing its poles, and that the mean result obtained for the magnetic variation by this day's observations differs only two-tenths of a minute, or twelve seconds, from the mean result obtained on the 19th of February.

V. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE.

Date and place of observation.—1840, May 28th. At Gaines's Ferry, (Pendleton,) on the west or right bank of Sabine River; Texas. Latitude 31° 28′ 15″, N.; Longitude 93° 44′ 33″, W.

No. of Needle.	Polarity of marked end of needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation.	North end of Needle reads.	South end of Needle reads.	Mean of both ends of Needle.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
				H. M.	Deg. | Mins. & Tenths.	Deg. | Mins. & Tenths.	Deg. | Mins. & Tenths.		
1	N	E	E	0.20 P.M.	60 . 08 . 0	60 . 25 . 0	60 . 16 . 5		J.D.G.
"	"	W	W	1.10	61 . 40 . 0	61 . 22 . 0	61 . 31 . 0		
"	"	W	E	1.41	60 . 45 . 0	60 . 23 . 0	60 . 34 . 0		
"	"	E	W	2.13	61 . 35 . 0	62 . 00 . 0	61 . 47 . 5		

A very light north-east wind. Weather clear, and the atmosphere very dry all day.

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. | Mins. & Tenths.	South end of Needle reads Deg. | Mins. & Tenths.	Mean of both ends of needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	S	E	E	4 . 45 P.M.	60 . 35.0	60 . 45.0	60 . 40.0		J.D.G.
"	"	W	W	5 . 40	60 . 05.0	60 . 00.0	60 . 02.5		
"	"	W	E	6 . 20	61 . 28.0	61 . 23.0	61 . 25.5		
"	"	E	W	6 . 23	61 . 50.0	62 . 00.0	61 . 55.0		

Needle No. 1, with marked end north, gives . . . . . 61° 02′.5
Needle No. 1, with marked end south, gives . . . . . 61 00′.75
Magnetic dip, by sixteen observations on needle No. 1, ... 61 01′.6

A very light south-west wind; weather clear, and the atmosphere very dry, all day.

May 29th, at Gaines's Ferry.

2	S	E	E	6 . 30 P.M.	55 . 15.0	55 . 30.0	55 . 22.5		
"	"	W	W	6 . 35	65 . 10.0	65 . 00.0	65 . 05.0		
"	"	W	E	6 . 40	55 . 35.0	55 . 15.0	55 . 25.0		
"	"	E	W	6 . 47	64 . 52.0	65 . 15.0	65 . 03.5		
2	N	W	W	7 . 05 A.M.	56 . 40.0	56 . 50.0	56 . 45.0		
"	"	E	E	7 . 12	65 . 55.0	65 . 35.0	65 . 45.0		
"	"	E	W	7 . 20	56 . 50.0	56 . 40.0	56 . 45.0		
"	"	W	E	7 . 25	66 . 00.0	66 . 25.0	66 . 12.5		

Needle No. 2, gives, with marked end north, ... 61° 22′*
With marked end south, ... 60 14′
Dip, by sixteen observations on needle No. 2, ... 60 48′
Dip, by sixteen observations on needle No. 1, ... 61 01′.6

* It will be remarked that the difference between the readings of needle No. 2 with the marked side east, and those which it gives with the marked side west, is very great, amounting to an average of nearly ten degrees in the last observations made upon it. The needle has assumed this character since I parted with it at our camp near the mouth of the river Sabine, on the 17th of March last.

Lieutenant Lee, who has had charge of the instrument since that time until my arrival at Gaines's Ferry, on the 27th of May, states, that while observing upon it at Gaines's Ferry, in the early part of April last, a violent storm, accompanied with thunder and lightning, interrupted his observations.

He left the instrument in the observing tent with this needle suspended, as is usual, for observation, and retired to his own tent until the storm should subside. During his absence from it, a very severe shock of lightning occurred, which was sensibly felt by several persons in the neighbouring tents. After the storm was over, he returned to the instrument, and found that the needle had been thrown from its position by the shock of lightning, although the tent and the other parts of the instrument remained apparently uninjured.

Ever after this, the needle showed similar discrepant results in its direct and reversed positions on its axis, although the mean result by it did not appear to differ much more than formerly from that shown by needle No. 1. Needle No. 2 had, after the accident, evidently a warp in it, which had not before been perceived. This may have arisen from the effect of the lightning upon the fibres of the steel. The axis may also have possibly been thrown somewhat out of its former adjustment. I have thought that under all circumstances, it would be just to give, in the last observations and always hereafter, twice the weight to the results of needle No. 1 which are given to those of needle No. 2, and in this way to state the dip as deduced from both needles.

Accordingly, by the last observations,—

The result by needle No. 1, = 61° 01′.6 × 2 = 122° 03′.2
The result by needle No. 2, = 60° 47′.9 × 1 = 60° 47′.9
The sum, = 182° 51′.1

which, divided by 3, gives 60° 57′ for the dip deduced for Gaines's Ferry, on the 28th and 29th of May, 1840.

VI. May 29th, 1840.—At Gaines's Ferry, west bank of the Sabine river; Texas. Latitude 31° 28′ 15″, N.; Longitude 93° 44′ 33″, W. Same station as V.

Magnetic bearing of a true meridian line established by equal altitudes of the sun, to ascertain the variation of the magnetic needle.*

1. By compass No. 3, needle six inches long. Poles of needle *direct.*
A mean of six observations made as heretofore described, gives, . . . 8° 35′.5 E.
Mean time of observation, 9*h*. 05*m*., A. M.
Poles of needle *reversed.* A mean of six observations made as heretofore described, gives . . . . . 8° 36′.6
Mean time of observation, 10*h*. 45*m*., A. M.
Magnetic variation by twelve observations on the needle of compass No. 3, 8° 36′ E.

2. By compass No. 4, needle five and a quarter inches long. Poles of needle *direct.* A mean of six observations made as heretofore described, gives, ... 8° 45′.5 E.
Mean time of observation, 9*h*. 40*m*., A. M.
Poles *reversed.* A mean of six readings made as heretofore described, gives, 8° 44′.6
Mean time of observation, 11*h*. 05*m*. A. M.
Magnetic variation by twelve observations on needle of compass No. 4, . . 8° 45′ E.

5. By the compass belonging to the Texan commissioner; needle six inches long.
A mean of six observations made as heretofore described, ... 8° 40′.6
Mean time of observation, 11*h*. 20*m*. A. M.
This needle could not conveniently be taken out of its box, and its poles were not therefore reversed.

SUMMARY.

1. Variation of the needle of compass No. 3, of six inches long, by a mean of twelve observations, ... 8° 36′ E.
2. Variation of the needle of compass No. 4, of five and a quarter inches long, by a mean of twelve observations . . . . . 8° 45′
3. Variation of the needle of the Texan commissioner's compass, of six inches long, by a mean of six observations, ... 8° 40′.6

Magnetic variation at Gaines's Ferry, Texas, in latitude 31° 28′ 15″, N.; and longitude 93° 44′ 33″, W.; by a mean of thirty observations on three needles, on the 29th of May, 1840, ... 8° 40′.5 E.

* This true meridian line was fixed by my principal assistant, Lieutenant T. J. Lee, of the corps of topographical engineers, on the 10th of May, 1840, before my arrival at Gaines's Ferry. It was done by observing the ⊙'s azimuth, at equal altitudes, A. M. and P. M., and correcting for the effect of the change of declination during the interval. Two stakes were driven to indicate the true meridian direction. The magnetic bearing of this line was observed by me with the several needles, as indicated.

NOTE.—The day was clear, with a very light north-east wind, and the atmosphere very dry.

From the difference in latitude between Everett's house, near the mouth of the river Sabine and Gaines's Ferry, amounting as it does, to 1° 44′ 21″, it was supposed there would be found a considerable difference in the variation of the needle at these two places.—The results here reported show, however, no appreciable difference. On perceiving this, I was induced to apprehend there might have been some inadvertent error in the determination of the true meridian at the latter station. The calculations were therefore received with care, and were found to give the correct deduction from the observations as recorded.

Lieutenant Lee has full confidence in his observations for the determination of the true meridian at Gaines's Ferry. For this purpose two separate sets of observations were made by him of the sun's azimuth, at equal altitudes, A.M. and P.M., and the results coincided within thirteen seconds of arc. There could have been no error in the magnetic bearing of the line indicated by the stakes placed by him to mark the true meridian, as the many observations with the different compasses used, would no doubt have detected such error.

The determination of the true meridian at Everett's house was done with every possible care, by observations on the star Polaris, verified by two different night's observations, using, in both instances, an artificial horizon of quicksilver, and observing the azimuth of the star both direct and by reflection.

VII. June 4th and 5th, 1840.—Observations on the dip of the needle, at a point about seven hundred feet north of Polvido's house, near the left bank of Sabine River, Louisiana. Latitude 32° 01′ 01″, N.; Longitude 94° 00′ 00″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Dip observed.
S June 4,	8	12*h*. 20*m*. P.M.	61° 20′.25
N June 5,	8	11 17 A.M.	61° 57′.75
Dip, by sixteen observations on needle No. 1, . . .			61° 39′.0

NEEDLE No. 2.

N June 5,	8	5*h*. 37*m*. P.M.	61° 53′.4
S June 5,	8	6 32 "	61° 11′.9
Dip, by sixteen observations on needle No. 2, . . .			61° 32′.6
Dip, by sixteen observations on needle No. 1, . . .			61° 39′.0

By giving to needle No. 1 twice the weight of No. 2, we get the following result for the dip at this station, viz:

No. 1, = 61° 39′	× 2, =	123° 18′
No. 2, = 61° 32′.6	× 1, =	61° 32′.6
Sum, ...		184° 50′.6

Which, divided by 3, gives 61° 36′.8 for the magnetic dip at this station on the 4th and 5th of June, 1840.

NOTE.—The point of observation is N. 70° E., (compared with the *true* meridian,) and is distant two and a half miles from the intersection of the river Sabine with the 32° of north latitude.

Clear, calm, very hot and dry weather, during the observations.

VIII. Nachitoches, Louisiana.

June 26, 1840.—Observations on the dip of the needle, made in the small summer-house in Mr. Ochmichen's garden.

NEEDLE No. 1.

Polarity of Marked end of Needle.	No. of Readings.	Time of Observation.	Dip observed.
N	8		61° 26′.25
S	8	3*h.* P. M.	61° 05′.62

Dip by sixteen observations on needle No. 1, 61° 15′.9

The day was clear and very hot, with a gentle north-west wind all day.

There was not time to observe on needle No. 2 before the hour appointed for the steam-boat to depart, in which I was to descend the Red river.

IX. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE.

Date and place of observation.—1840, August 24th.—At West Point, New York. Latitude 41° 23′ 35″, N.; Longitude 74° 01′ W. The observations were made under a tent on the plain, about one hundred yards west of Execution Hollow, and remote from the batteries of artillery and other visible causes of local attraction.

Weather clear, with a fresh breeze from the north.

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Markedside of Needle.	Mean solartime of observation. H. M.	North end of Needle reads ! Deg. | Mins. & Tenths.	South end of Needle reads Deg. | Mins & Tenths.	Mean of both ends of Needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	S	W	W	7.40 A. M.	72 . 05	72 . 25	72 . 15		J. D. G.
"	"	E	E	8.11	74 . 36	74 . 20	74 . 28		
"	"	E	W	9.00	72 . 42	72 . 22	72 . 32		
"	"	W	E	10.30	73 . 25	73 . 46	73 . 35.5		
1	N	W	W	11.30 A. M.	73 . 58	74 . 30	74 . 14		
"	"	E	E	11.48	72 . 33	72 . 16	72 . 24.5		
"	"	E	W	0.15 P. M.	74 . 30	74 . 07	74 . 18.5		
"	"	W	E	0.40	72 . 22	72 . 45	72 . 33.5		

Needle No. 1, with marked end south, gives . . . . . 73° 12′.6
Needle No. 1, with marked end north, gives . . . . . 73 22′.6
Dip, by sixteen observations on needle No. 1, ... 73 17′.6

2	S	W	W	3.20 P. M.	78 . 20	78 . 45	78 . 32.5		
"	"	E	E	3.27	68 . 33	68 . 05	68 . 19		
"	"	E	W	3.35	78 . 22	78 . 00	78 . 11		
"	"	W	E	3.40	68 . 03	68 . 22	68 . 12.5		
2	N	W	W	4.05 P. M.	68 . 45	69 . 03	68 . 54		
"	"	E	E	4.10	78 . 37	78 . 15	78 . 26		
"	"	E	W	4.18	68 . 55	68 . 30	68 . 42.5		
"	"	W	E	4.25	77 . 50	78 . 15	78 . 05		

Needle No. 2, with marked end south, gives, ... 73° 18′.75
Needle No. 2, with marked end north, ... 73 31′.37
Dip, by sixteen observations on needle No. 2, ... 73 25′.06
A direct mean between the results of No. 1 and No. 2 is, ... 73 21′.3
By giving twice the weight to No. 1 which is given to No. 2, the dip will be, 73° 20′.09

NOTE.—This is the last observation ever made with needle No. 2. It was broken, a few days afterwards in an attempt to correct it of the warp which occurred from the accident described at page 339. Two other needles were subsequently made for this instrument by Mr. J. N. Baur, a very ingenious mechanic of New York. They are designated as No. 3 and 4 in the observations which follow, and proved to be remarkably good needles.

X. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE.

Date and place of observation.—1840, October 18th.—At astronomical station, four thousand five hundred and seventy-eight feet due north from the monument at the source of the river St. Croix; on the boundary between Maine and New Brunswick. Latitude 45° 57′ 23″.6, N.; Longitude 67° 46′ 45″, west of Greenwich.

No. of Needle.	Polarity of marked end of needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation.	North end of Needle reads.	South end of Needle reads.	Mean of both ends of Needle.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
				H. M.	Deg. | Mins. & Tenths.	Deg. | Mins. & Tenths.	Deg. | Mins. & Tenths.		
3	N	E	E	1.30 P.M.	76 . 37	76 . 15	76 . 26		J.D.G.
"	"	W	W	1.45	77 . 05	77 . 28	77 . 16.5		
"	"	W	E	1.50	76 . 15	76 . 35	76 . 25		
"	"	E	W	1.55	77 . 30	77 . 07	77 . 18.5		

Weather clear and dry.

3	S	E	E	2.40 P.M.	77 . 10	76 . 52	77 . 01	52°	J.D.G.
"	"	W	W	2.48	76 . 57	77 . 07	77 . 02		
"	"	W	E	3.00	76 . 55	77 . 15	77 . 05		
"	"	E	W	3.10	77 . 08	76 . 52	77 . 00		

Needle No. 3, with marked end north, gives, ... 76° 51′.5
Needle No. 3, with marked end south, gives, ... 77° 02
Dip by sixteen observations on needle No. 3, ... 76° 56′.75

1840—October 20th.—At the same station, observed on needle No. 4 as follows, viz.:

4	N	E	E	11.05 A.M.	75 . 45	75 . 15	75 . 30	60°	J.D.G.
"	"	W	W	11.20	77 . 50	78 . 10	78 . 00		
"	"	W	E	11.25	75 . 20	75 . 20	75 . 20		
"	"	E	W	11.30	78 . 05	77 . 50	77 . 57.5		
4	S	E	E	0.15 P.M.	78 . 38	78 . 15	78 . 26.5	61°5	J.D.G.
"	"	W	W	0.25	75 . 30	75 . 45	75 . 37.5		
"	"	W	E	0.30	78 . 08	78 . 22	78 . 15		
"	"	E	W	0.38	76 . 40	76 . 10	76 . 25		

It was raining the whole time occupied in observing on needle No. 4, to-day, and the atmosphere was very moist, but the needle and its axis, and also the agate supports at the centre of the dip circle, were kept as dry as possible by frequently wiping them with soft chamois leather.

Needle No. 4 gives, with marked end north, ... 76° 41′.87
With marked end south, ... 77° 11′
Dip by sixteen observations on needle No. 4, ... 76° 56′.43

NOTE.—Needles No. 3 and No. 4, made by J. N. Baur, of New York, were furnished by him unmagnetized. They were magnetized on the 18th of October, and the above are the first observations ever made with them.

Date and place of observation.—1840—October 20th.—At the same station as before.

1	S	E	E	2.15 P.M.	78 . 30	78 . 19	78 . 24.5	63°	J.D.G.
"	"	W	W	2.55	75 . 40	75 . 55	75 . 47.5	63	
"	"	W	E	3.27	76 . 07	76 . 25	76 . 16	60	
"	"	E	W	3.55	78 . 27	78 . 10	78 . 18.5	61	

At 2*h*. 55*m*., cloudy: 3*h*. 27*m*., raining: 3*h*. 55*m*., sky clear, flying clouds.

October 21st, reversed the poles of needle No. 1, and observed as follows:

No. of Needle.	Polarity of marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. Mins. & Tenths.	South end of Needle reads Deg. Mins. & Tenths.	Mean of both ends of Needle. Deg. Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	4.15 P.M.	76 . 15	75 . 52	76 . 03.5	53°	J.D.G.
"	"	W	W	4.30	77 . 30	77 . 52	77 . 41	53	
"	"	W	E	4.38	75 . 40	75 . 55	75 . 47.5	53	
"	"	E	W	5.05	77 . 37	77 . 35	77 . 36	53	

Needle No. 1, with marked end south, gives, October 20th, ... 77° 11′.6
Needle No. 1, with marked end north, gives, October 21st, ... 76° 47
Dip, by sixteen observations on needle No. 1, ... 76° 59′.3

RECAPITULATION,

Showing the result of all the observations on needles Nos. 1—3, 4, for the magnetic dip, at the first astronomical station of the north-eastern boundary survey, being four thousand five hundred and seventy-eight feet due north of the monument erected at the source of the river St. Croix; made on the 18th, 20th, and 21st of October, 1840:

1. By sixteen observations on needle No. 3, October 18th, 1840, ... 76° 56′.75
2. " " " No. 4, October 20th, 1840, ... 76° 56′.43
3. " " " No. 1, October 21st, 1840, ... 76° 59′.3

Magnetic dip at station four thousand five hundred and seventy-eight feet due north from the monument, by a mean of forty-eight observations on needles Nos. 1, 3, and 4, October 18th, 20th, and 21st, 1840, ... 76° 57′.4

XI. November 27th, 1840.—Observations on the dip of the magnetic needle, at astronomical station, Park's hill, on the true meridian of the monument at the source of the river St. Croix. Latitude 46° 06′ 40″, N.; Longitude 67° 46′ 45″, W.

NEEDLE No. 3.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Dip observed.
S	8	2*h.* 48*m.*, P.M.	77° 03′
N	8	3 57 "	76° 55′.9

Dip, by sixteen readings of needle No. 3, ... 76° 59′.4

November 28th, 1840. At same station.

NEEDLE No. 4.

S	8	77° 23′.37
N	8	76° 48′.37

Dip, by sixteen readings of needle No. 4, November 28th, 77° 05′.87

November 29th,—at same station as above.

NEEDLE No. 3, REPEATED.

N	8	77° 03′
S	8	77° 01′.6

Dip, by sixteen readings of needle No. 3, November 29, 1840, 77° 02′.3
Dip, by sixteen readings of needle No. 4, November 28, " 77° 05′.87
Dip, by sixteen readings of needle No. 3, November 27, " 76° 59′.4

Magnetic dip at Park's Hill, by a mean of forty-eight observations, on needles Nos. 3 and 4, made on the 27th, 28th, and 29th of November, 1840, . . 77° 02′.5

The observations were made under a tent for the protection of the instrument; the snow nearly a foot deep upon the ground.

There was a slight fall of snow during the observations, on the 27th and 28th of November.

On the 29th it was cloudy. Needle No. 3 was more strongly charged with magnetism on the 29th than on the 27th. On the 29th pains were taken to charge it fully to saturation, and it vibrated more briskly than on the 27th.

A continuation of Observations on the Dip of the Magnetic Needle; embracing thirty-eight additional points in the United States, New Brunswick, and Canada, between Washington and the head waters of the River St. John. Made during the years 1841, 1843, *and* 1844. *By James D. Graham, Major, United States Corps of Topographical Engineers. Read January* 17, 1845.

The instrument with which the following observations were made, was constructed by Gambey, of Paris, and is probably one of the best that has come from the hands of that ingenious and skilful artist. The close coincidence which has uniformly been shown in the results of its two needles, and the consistency in the repeated readings requisite for the many sets of observations that have been made with it, seem fully to justify this remark.

It is constructed of gun-metal, except the cover for the dip-circle. This is a square box open at the base, for passing it over the dip-circle, and has a door opening and shutting on hinges, for convenience in placing and adjusting the needles, and is made chiefly of wood, and fine plate glass.

The vertical or dip-circle is ten inches in diameter, and is divided, as usual, into four quadrants of ninety degrees each. The degrees are divided each into six equal parts, or directly to ten minutes. These smaller divisions are easily subdivided by estimation, after a little practice, aided by the magnifying lenses that are attached to the instrument, to the nearest one or two minutes.

It has two needles, each nine and a half inches long, and nine-sixteenths of an inch wide in the middle where pierced by the axle. They are here gently rounded upon both narrow edges, and taper thence to a point at each extremity. They play entirely within the interior ring of the dip-circle, whose diameter is one-twentieth of an inch greater than the length of the needles, leaving one-fortieth of an inch clear space at each end of the needles. By this arrangement, all parallax in reading the angle of the dip is avoided.

The pivots of the steel axles rest, and roll freely when the needles vibrate, upon two polished agates, whose upper surfaces are of cylindrical form.

The usual arrangement is provided, of a pair of brass Y's, which can be raised and depressed at pleasure, to lift the needles from the agates, and set them down again, for the purpose of giving a new bearing of the axles, or to shorten the vibration of the needles.

The azimuth circle is an open ring eight inches in diameter, connected by six radial bars with the socket at the centre. The quantity of metal round about the needles is thus diminished without any sacrifice of strength or steadiness. This circle is divided into degrees, numbered round from 0 to 360°, and these again into half degrees, and the readings are to single minutes by means of a vernier.

For bringing the plane of the dip-circle to coincide with the magnetic meridian, there is a horizontal needle nine and a quarter inches long, whose socket at the centre, rests upon the point of a pin projecting from the middle of a steel axle, whose pivots rest in the Y's of the dip-circle. The pin which supports the horizontal needle is kept vertical, by the gravity of a brass bob, diametrically opposite to it, also attached to the axle, and which serves as a handle in adjusting the needle concentric with the dip-circle.

This part of the apparatus is, of course, removed when the plane of the dip circle is brought to coincide with that of the magnetic meridian. It was attached to the instrument after it was imported into this country, by Mr. James Green, mathematical instrument maker, in Baltimore.

A very delicate spirit-level is provided, for levelling in azimuth, by means of three foot-screws. A pair of bar magnets and a good thermometer with Fahrenheit's scale, are appendages to the instrument, and are conveniently packed in the travelling case.

The needles are designated by the figures 1 and 2 respectively, marked upon the flat sides.

The method of observing has been the same as was described in a preceding portion of this paper, read before the Society on the 16th of August, 1844. That is, the needles were always read at both ends, in four different positions, with the poles direct, and in the same number again with the poles reversed. Two of these four changes were, in each case, made by reversing the face of the dip circle, and the two others by reversing the ends of the axles upon the agates.

When the instrument was first observed upon, the needle was read four times successively in each of its positions with respect to the instrument, in order to ascertain the degree of coincidence of these several readings, the needle being lifted from the agates and allowed to assume its rest anew after each reading. These several readings were found to differ so little in the same relative position of the needle, seldom amounting to as much as three minutes, and usually not exceeding one or two minutes, that it was considered unnecessary to read more than twice in the same position in order to eliminate errors of reading or of position of the axles upon the agates. Hence each needle has been usually read only twice at each end, in the same position, though at several stations they have been read as many as three times at each end, in each position.

The needles were always raised from the agates and allowed to assume their positions anew, after each reading.

In order to show more clearly the mode of observing, and, what is not less important, the character of the instrument, the observations made at Washington on the 1st, 4th,

and 5th of June, 1841, and those made at the observatory of the Girard college, Philadelphia, on the 14th of the same month, are given in full detail. All the other observations are reported in an abbreviated form.

It is proper to remark, that, at all the stations embraced by this paper, the several readings of the two needles were quite as consistent as those reported at full length.

The latitude and longitude of every station are given. With the exception of the stations at Washington, Baltimore, Philadelphia, New York, Boston, Cambridge Massachusetts, and Portsmouth New Hampshire, these have been exclusively derived from numerous astronomical observations made by the author of this paper.

The precise locality of each station, with respect to conspicuous surrounding objects, is also given, to enable future observers to place their instruments upon the same points, in order to a fair comparison of results, and for a more satisfactory deduction of the periodical variation of the dip.

Although the instrument has been transported over about four thousand miles in the various journeys made with it, sometimes in rail-cars, sometimes in stage-coaches, sometimes in baggage wagons, over exceedingly rough roads, and sometimes in log and bark canoes, while navigating shoal rivers, abounding with rocks and dangerous rapids, yet it is uninjured in the slightest degree. The last observations made with it are quite as satisfactory as any of the series. This is to be attributed to the admirable manner in which the instrument is packed in its travelling-case, and the attention that was always bestowed to ensure its safety.

The temperature is always given by the scale of Fahrenheit.

The longitudes are always given west of Greenwich.

The time of observation given is always mean solar time, by civil reckoning.

XII. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE, WITH INSTRUMENT BY GAMBEY, OF PARIS.

Date and place of observation.—1841, June 1st.—Washington City, D. C. In the centre of the public garden, east of the capitol. Latitude 38° 53′ 30″, N.; Longitude 77° 01′ 30″, W.

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Markedside of Needle.	Mean solartime of observation. H. M.	North end of Needle reads Deg. Mins. & Tenths.	South end of Needle reads Deg. Mins. & Tenths.	Mean of both ends of Needle Deg. Mins. & Tenths.	Attached Thermometer (Fahrenheit.)	Name of Observer.
1	N	E	E	8.16 A. M.	71 . 15	71 . 18	71 . 16.5	76°	Major J. D. Graham.
"	"	"	"	8.20	71 . 14	71 . 18	71 . 16		
"	"	"	"	8.24	71 . 12	71 . 15	71 . 13.5		
"	"	"	"	8.30	71 . 11	71 . 15	71 . 13		
"	"	W	W	8.40	71 . 00	70 . 56	70 . 58	78	
"	"	"	"	8.45	70 . 57	70 . 52	70 . 54.5		
"	"	"	"	8.50	70 . 58.5	70 . 54	70 . 56.2	78	
"	"	"	"	8.55	70 . 59	70 . 55	70 . 57		
"	"	W	E	9.10	71 . 35	71 . 29	71 . 32	79	
"	"	"	"	9.12	71 . 35	71 . 27	71 . 31	80	
"	"	"	"	9.18	71 . 35	71 . 29	71 . 32		
"	"	"	"	9.20	71 . 35	71 . 28	71 . 31.5	81	
"	"	E	W	9.33	70 . 42.5	70 . 49	70 . 45.7	82	
"	"	"	"	9.35	70 . 44	70 . 50	70 . 47		
"	"	"	"	9.37	70 . 43	70 . 49	70 . 46	83	
"	"	"	"	9.40	70 . 43	70 . 48	70 45.5	84	

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. | Mins. & Tenths.	South end of Needle reads Deg | Mins. & Tenths.	Mean of both ends of needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	S	E	E	10.28 A. M.	70 . 52.5	70 . 58	70 . 55.2	84°	Major J. D. Graham.
"	"	"	"	10.34	70 . 53	70 . 58	70 . 55		
"	"	"	"	10.36	70 . 53.5	70 . 57	70 . 55.2		
"	"	"	"	10.38	70 . 54	70 . 58	70 . 56		
"	"	W	W	10.45	72 . 09	72 . 04	72 06.5		
"	"	"	"	10.46	72 . 10	72 . 02	72 . 06		
"	"	"	"	10.48	72 . 10	72 . 05	72 . 07.5	88	
"	"	"	"	10.50	72 . 11	72 . 04	72 . 07.5		
"	"	W	E	10.56	71 . 22.5	71 . 18.5	71 . 20.5		
"	"	"	"	10.57	71 . 24	71 . 17	71 . 20.5		
"	"	"	"	10.58	71 . 24	71 . 19	71 . 21.5		
"	"	"	"	10.59	71 . 22.5	71 . 17.5	71 . 20		
"	"	E	W	11.05	71 . 14	71 . 19	71 . 16.5		
"	"	"	"	11.06	71 . 14	71 . 18	71 . 16		
"	"	"	"	11.08	71 . 14	71 . 18	71 . 16		
"	"	"	"	11.09	71 . 14	71 . 17.5	71 . 15.7		

Needle No. 1, gives, with marked end north, ... 71° 07′.27
with marked end south, ... 71° 24′.72
Dip, by sixty-four observations on needle No. 1, ... 71° 16′

Four readings were taken of the needle in each position, in order to test the consistency of the several results. After each reading, the needle was raised from the agate supports and allowed to assume new points of rest upon the pivots.

The weather was clear and the atmosphere dry, and a very light south-easterly wind perceptible.

The above are the first observations ever made with this instrument. It arrived from Paris only a few weeks ago. Its two needles came unmagnetized, and were both magnetized this morning, before commencing the observations. Observations on needle No. 2 were omitted this day, in consequence of the high degree of temperature, and the difficulty of procuring a proper shade for the instrument, as late in the day as noon.

1841, June 4th.—Washington City, D. C. Near the centre of the public garden, east of the capitol, under an elm tree which is on the south margin of the northern middle avenue, or gravelled walk, running east and west.

2	S	E	E	7.20 A. M.	71 . 20	71 . 24	71 . 22	65°	J. D. G.
"	"	"	"	7.30	71 . 21	71 . 25	71 . 23		J. D. G.
"	"	W	W	7.45	71 . 07	70 . 59	71 . 03	68	J. N. N.
"	"	"	"		71 . 06	70 . 59	71 . 02.7		J. D. G.
"	"	W	E	8.00	71 . 39	71 . 34	71 . 36.5	68.5	J. N. N.
"	"	"	"		71 . 39.5	71 . 34	71 . 36.7		J. D. G.
"	"	E	W	8.07	71 . 34	71 . 39	71 . 36.5	70	J. N. N.
"	"	"	"		71 . 34	71 . 39.5	71 . 36.7		J. D. G.
2	N	E	E	8.50	70 . 51	70 . 56	70 . 53.5	73	J. N. N.
"	"	"	"		70 . 52	70 . 55	70 . 53.5		J. D. G.
"	"	W	W	9.00	71 . 40	71 . 35	71 . 37.5	74	J. N. N.
"	"	"	"		71 . 41	71 . 36.5	71 . 38.7		J. D. G.
"	"	W	E	9.07	71 . 01.5	70 . 56	70 . 58.2	74	J. N. N.
"	"	"	"		71 . 02.5	70 . 57	70 . 59.2		J. D. G.
"	"	E	W	9.12	71 . 32	71 . 37	71 . 34.5	74	J. N. N.
"	"	"	"		71 . 33	71 . 37	71 . 35		J. D. G.

I was this day joined in the observations by Mr. J. N. Nicollet. We read the needles alternately, and they were raised from their supports and allowed to assume new bearings between the successive readings. The initials J. N. N. and J. D. G. will show the observations made by each of us. The position of the instrument, this morning, was slightly changed from that of June 1st, in order to procure a better shade.

Needle No. 2, gives, with marked end north, ... 71° 16′.26
with marked end south, ... 71° 24′.38
Dip, by thirty-two observations on needle No. 2, ... 71° 20′.32

NOTE.—The precise position of the instrument, during this day's observations, was fixed by measurement as follows, viz.:

1. From the instrument to the iron gate west of it, measured along the gravelled walk, is 313 feet. This gate is 198 feet east of the row of pillars on the east portico of the capitol.

2. From the position of the instrument to the eastern iron gate, measured along the gravelled walk on whose south margin the instrument stands, is 261 feet.

1841, June 4th.—Washington City, D. C.

No. of Needle.	Polarity of marked end of needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads. Deg. | Mins. & Tenths.	South end of Needle reads. Deg. | Mins. & Tenths.	Mean of both ends of Needle. Deg. | Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	S	E	E	9.50 A.M.	70 . 32.5	70 . 36	70 . 34.2	75°	J.N.N.
"	"	"	"		70 . 31.5	70 . 35.5	70 . 33.5		J.D.G.
"	"	W	W	9.56	72 . 15	72 . 08	72 . 11.5	76	J.N.N.
"	"	"	"		72 . 16	72 . 08	72 . 12		J.D.G.
"	"	W	E	10.04	71 . 30	71 . 23	71 . 26.5	77	J.N.N.
"	"	"	"		71 . 30	71 . 24	71 . 27		J.D.G.
"	"	E	W	10.14	71 . 21	71 . 27	71 . 24	77	J.N.N.
"	"	"	"		71 . 21.5	71 . 26	71 . 23.7	77	J.D.G.
1	N	E	E	10.30	71 . 21	71 . 27	71 . 24.5	77.5	J.N.N.
"	"	"	"		71 . 21.5	71 . 26	71 . 23.7		J.D.G.
"	"	W	W	10.38	71 . 06	70 . 59	71 . 02.5		J.N.N.
"	"	"	"		71 . 06	71 . 00.5	71 . 03.2		J.D.G.
"	"	W	E	10.42	71 . 29	71 . 21	71 . 25	78	J.N.N.
"	"	"	"		71 . 28	71 . 22.5	71 . 25.2		J.D.G.
"	"	E	W	11.00	70 . 46.5	70 . 51	70 . 48.7	79	J.N.N.
"	"	"	"		70 . 46	70 . 51	70 . 48.5		J.D.G.

Needle No. 1, gives, with marked end north, ... 71° 10′.16
with marked end south, ... 71° 24′.05
Dip, by thirty-two observations on needle No. 1, ... 71° 17′.10
Dip, by thirty-two observations on needle No. 2, ... 71° 20′.32

1841, June 4th.—Dip, near the centre of the public garden, east of the capitol, Washington City, by a mean of both needles of Gambey, . . . 71° 18′.7

The close coincidence of the repeated readings of the needles of this instrument, in the various positions necessary for a complete result, induced Mr. Nicollet to express a wish that we should institute a comparison, by means of simultaneous observations, between the dip, as given by this instrument, and that given by his instrument, made by Robinson, of London. He accordingly sent to Baltimore for his instrument, to be brought to Washington by the next morning's early cars. It arrived early on the morning of June 5th, and we continued the observations, each using his own instrument, as follows, viz.:

OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE, WITH INSTRUMENT BY GAMBEY, OF PARIS.

1841, June 5th.—Washington City, D. C. Same position as on the 4th, viz., under an elm-tree which is on the south margin of the northern middle avenue or gravelled walk, running east and west through this garden.

No. of Needle.	Polarity of marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. Mins. & Tenths.	South end of Needle reads Deg. Mins. & Tenths.	Mean of both ends of Needle. Deg. Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	7.30 A.M.	71 . 18	71 . 21	71 . 19.5	73°	Maj. J. D. Graham.
"	"	"	"		71 . 20	71 . 23	71 . 21.5		
"	"	W	W	7.40	71 . 01	70 . 55	70 . 58	74	
"	"	"	"		71 . 02	70 . 56	70 . 59		
"	"	W	E	7.50	71 . 30	71 . 27	71 . 28.5	74	
"	"	"	"		71 . 31	71 . 24	71 . 27.5		
"	"	E	W	8.00	70 . 51	70 . 55.5	70 . 53.2	75	
"	"	"	"		70 . 51	70 . 55.5	70 . 53.2		
1	S	E	E	8.20	70 . 51	70 . 56	70 . 53.5	76	Maj. J. D. Graham.
"	"	"	"		70 . 51	70 . 56	70 . 53.5		
"	"	W	W	8.30	71 . 42	71 . 38	71 . 40	77	
"	"	"	"		71 . 43	71 . 38	71 . 40.5		
"	"	W	E	8.40	71 . 12.5	71 . 08	71 . 10.2	78	
"	"	"	"		71 . 13.5	71 . 08	71 . 10.7		
"	"	E	W	8.50	71 . 23.5	71 . 27	71 . 25.2	79	
"	"	"	"		71 . 23.5	71 . 27.5	71 . 25.5		

The position of Mr. Nicollet's instrument is seventy feet in a direction west and perpendicular to the magnetic meridian from my instrument. He is going on with his observations simultaneously with mine.

Needle No. 1 gives, with marked end north, ... 71° 10′.05
with marked end south, ... 71° 17′ 39
Dip, by thirty-two observations on needle No. 1, ... 71° 13′.72

1841, June 5th.—Washington City, D. C. Same position.

2	N	E	E	9.35 A.M.	70 . 47	70 . 50.5	70 . 48.7	82°	Maj. J. D. Graham.
"	"	"	"		70 . 47	70 . 51	70 . 49		
"	"	W	W	9.55	71 . 41	71 . 35	71 . 38	84	
"	"	"	"		71 . 40	71 . 34	71 . 37		
"	"	W	E	10.00	71 . 01	70 . 56	70 . 58.5	86	
"	"	"	"		71 . 02.5	70 . 56.5	70 . 59.5		
"	"	E	W	10.08	71 . 28	71 . 33	71 . 30.5	86	
"	"	"	"		71 . 28.5	71 . 32.5	71 . 30.5		
2	S	E	E	10.25	71 . 15	71 . 20	71 . 17.5	86°	Maj. J. D. Graham.
"	"	"	"		71 . 15	71 . 19	71 . 17		
"	"	W	W	10.35	71 . 01.5	70 . 55	70 . 57.7	86	
"	"	"	"		71 . 00.5	70 . 55	70 . 57.2		
"	"	W	E	10.40	71 . 32.5	71 . 26	71 . 29.2	86	
"	"	"	"		71 . 32.5	71 . 26	71 . 29.2		
"	"	E	W	10.45	70 . 44.5	70 . 48	70 . 46.2	87	
"	"	"	"		70 . 43.7	70 . 48.5	70 . 46.1		

Needle No. 2 gives, with marked end north, ... 71° 13′.96
with marked end south, ... 71° 07′.51
Dip, by thirty-two observations on needle No. 2, ... 70° 10′.73
Dip, by thirty-two observations on needle No. 1, ... 71° 13′.72

1841, June 5th.—Dip, near the centre of the public garden, east of the capitol, by a mean of both needles of Gambey, ... 71° 12′.22

Mr. Nicollet transcribed in my note-book, with his own hand, the result of his observations with his own instrument, and requested me, when I reported mine, to report his also. They are as follows, viz.:

OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE, WITH INSTRUMENT BY ROBINSON, OF LONDON.

Date and place of observation.—1841, June 5th.—Washington City. In the public garden east of the capitol, and occupying a point thirty-nine feet west of the centre of the garden, and seventy feet west of Major Graham's instrument.

No. of Needle.	Polarity of Marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	Mean of both ends of Needle. Deg. Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	7.10 A.M.	71 . 00	72°	Mr. J. N. Nicollet.
"	"	W	W		71 . 18		
"	"	W	E		71 . 07		
"	"	E	W		71 . 18		
1	N	E	E		71 . 12		
"	"	W	W		71 . 07		
"	"	W	E		71 . 21		
"	"	E	W		71 . 07		
1	S	E	E		71 . 30		
"	"	W	W		71 . 05	77	
"	"	W	E		71 . 41		
"	"	E	W	8 . 30	71 . 00		
2	N	E	E	9 . 00	70 . 57.5		Mr. J. N. Nicollet.
"	"	W	W		71 . 34	79	
"	"	W	E		71 . 03.5		
"	"	E	W		71 . 34		
2	S	E	E		71 . 25.5		
"	"	W	W		71 . 06.5		
"	"	W	E		71 . 30.5		
"	"	E	W	10 . 05	70 . 53.5	84	

"Note.—Each observation recorded is a mean of three readings of each end of the needle.—J. N. N."

"Having applied the magnets to this needle, intending to reverse the poles, it was suspended for observation, when it was found, that, through a mistake in applying the magnets, the poles were not reversed.—J. N. Nicollet."

Needle No. 1, with marked end north, gives, ... 71° 11′.25
with marked end south, gives, ... 71° 19′
Dip, by needle No. 1, ... 71° 15′.12

"Weather fine; light clouds near the horizon; light north-west wind."

Needle No. 2 gives, with marked end north, ... 71° 17′.25
with marked end south, ... 71° 14′
Dip, by forty-eight observations on needle No. 2, ... 71° 15′.62
Dip, by seventy-two observations on needle No. 1, as above, ... 71° 15′.12

1841, June 5th.—Washington City, near the centre of the public garden, east of the capitol. Dip, by a mean of two needles, as observed by Mr. Nicollet, with his instrument, by Robinson, of London, ... 71° 15′.37

RECAPITULATION,

Showing the results of all the observations for the magnetic dip made at Washington, D. C., on the 1st, 4th, and 5th of June, 1841, by Major J. D. Graham and Mr. J. N. Nicollet, with the two instruments used, namely, the one by Gambey, of Paris, and the other, by Robinson, of London.

The point of observation at Washington is in latitude 38° 53′ 30″, N.; longitude 77° 01′ 30″, W.

1841, June 1st.—Dip, by needle No. 1, as observed by Major J. D. Graham, with instrument by Gambey, ... 71° 16′.0
1841, June 4th.—Dip, by needle No. 1, as observed by Major Graham and Mr. Nicollet, with instrument by Gambey, ... 71° 18′.7
1841, June 4th.—Dip, by needle No. 2, as observed by Major Graham and Mr. Nicollet, with instrument by Gambey, ... 71° 20′.32
1841, June 5th.—Dip, by needle No. 1, as observed by Major Graham, with instrument by Gambey, ... 71° 13′.72
1841, June 5th.—Dip, by needle No. 2, as observed by Major Graham, with instrument by Gambey, ... 71° 10′.73
Dip, by a mean of one hundred and ninety-two observations, with instrument by Gambey, ... 71° 15′.89

Dip, by needle No. 1, as observed by Mr. Nicollet, with instrument by Robinson, ... 71° 15′.12
Dip, by Needle No. 2, as observed by Mr. Nicollet, with instrument by Robinson, ... 71° 15′.62
Dip, by a mean of one hundred and twenty observations, with instrument by Robinson, ... 71° 15′.37
Mean of three hundred and twelve observations for the dip, made on the 1st, 4th, and 5th of June, 1841, near the middle of the public garden, due east of the capitol, Washington City, by Major Graham and Mr. Nicollet, . . . 71° 15′.7

BALTIMORE.

The magnetic dip was observed at five separate stations at Baltimore, on the 9th, 10th, and 11th of June, 1841, as follows, viz.:

XIII. FIRST STATION.

This station was chosen in the shady grove of oaks north of the Washington monument. The precise locality of the station is N. 5° E. by needle, and three hundred and sixty-three yards, by measurement, from the centre of the Washington monument.

June 9th.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	1*h*. 07*m*. P. M.	94°.5	71° 54′.13
N	16	1 51 "	95	71° 42′.91

Dip by thirty-two observations on needle No. 1, ... 71° 48′.52

NEEDLE No. 2.

S	16	2*h*. 32*m*. P. M.	94°.5	71° 41′.65
N	16	2 59 "	94 .5	71° 55′.08

Dip, by thirty-two observations on needle No. 2, ... 71° 48′.36

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 71° 48′.44

The weather was clear, with a gentle breeze from the west-north-west during the observations of this day.

1841, June 10th.—Same station.

NEEDLE No. 1.

N	16	6*h*. 47*m*., A. M.	72°	71° 42′.51
S	16	7 20 "	74	71° 54′.47

Dip, by thirty-two observations on needle No. 1, ... 71° 48′.49

NEEDLE No. 2.

N	16	8*h*. 07*m*., A. M.	76°5	71° 50′.73
S	16	9 01 "	79	71° 36′.51

Dip, by thirty-two observations on needle No. 2, ... 71° 43′.62

Dip, by sixty-four observations on needles Nos. 1 and 2, made June 10, 1841. . . . . 71° 46′.05

XIV. Baltimore—second station.—June 10th, 1841.

In the second square north-east of the Washington monument, under a large white-oak tree, which bears S. 47° W., by the magnetic needle, and is distant one hundred and sixty-one feet by measurement from the curb-stone which marks the south-west corner of Calvert and Reed Streets. It is the largest tree in view on this hill, and affords ample shade.

NEEDLE No. 1.

S	16	11*h*. 41*m*., A. M.	85°	71° 37′.1
N	16	0 35 P. M.	86	71° 26′.46

Dip, by thirty-two observations of needle No. 1, ... 71° 31′.78

NEEDLE No. 2.

S	16	1*h*. 47*m*., P. M.	86°	71° 29′.63
N	16	2 20 "	86	71° 34′.73

Dip, by thirty-two observations on needle No. 2, ... 71° 32′.18

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 71° 32′

Weather clear and fine. Almost calm.

NOTE.—The dip was observed at this station by Professor A. D. Bache, of Philadelphia, on the 27th of August, 1840, to be 71° 34′.4. See proceedings of Am. Phil. Soc., vol. i. p. 295.

The following magnetic bearings were observed from this tree, in order still farther to identify the position of this station, viz.:

From the tree, the Washington monument bears S. 45° W.
" " the steeple of St. Paul's Church bears S. 13° W.
" " the dome of the Exchange bears S. 14° E.
" " the most western shot-tower bears S. 18° E.
" " the most eastern shot-tower bears S. 33° E.
" " the white steeple of a distant church bears N. 82° E.

The bearings are given as observed with a good prismatic compass.

I now felt curious to ascertain what would be the change of dip at positions intermediate of stations one and two, and also if the needles would be affected at those two stations by a line of iron pipes, which I was informed lay at a depth of four feet under ground, along the margin of an intermediate drain or valley, for conducting the water from a neighbouring spring-house.

I accordingly chose two intermediate points between stations one and two, which are called the third and fourth Baltimore stations.

The following observations and measurements were made to show the relative positions of these four stations with respect to one another. The bearings are magnetic and were observed with a prismatic compass. The distances were measured with a surveyor's chain.

From the centre of the Washington Monument to station one is N. 5° E., and distance 1089 feet.
From station one to station three is S. 35° E., and distance 212 feet.
From station three to station four is S. 8° E., and distance 181 feet.
From station four to station two is N. 78° E., and distance 449 feet.
Station No. 3 is forty-three feet north of the line of iron pipes.
Station No. 4 is one hundred and thirty-seven feet south of the line of iron pipes.

XV. Baltimore—third station.—June 10th, 1841.

NEEDLE No. 1.

Polarity of Marked end of Needle.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	8	3*h*. 52*m*., P. M.,	87°.5	71° 41′.05
S	8	4 52 "	87	71° 54′.85

Dip, by 16 observations on needle No. 1, first set, ... 71° 47′.9

The observations were repeated with needle No. 1 at this station, and the readings of the needle were made by Mr. James Green, of Baltimore, as follows, viz.:

S	8	5*h*. 27*m*., P. M.	85°	71° 57′.25
N	9	5 49 "	86	71° 39′.75

Dip, by sixteen observations on needle No. 1, second set, . . . 71° 48′.5

Dip, by thirty-two observations on needle No. 1, being a mean of two sets of observations . . . . . 71° 48′.2

XVI. Baltimore—fourth station.—June 10th, 1841.

NEEDLE No. 1.

N	8	6*h*. 46*m*., P. M.	80°	71° 45′.6
S	8	7 02 "	78	71° 55′.85

Dip, by sixteen observations on needle No. 1, ... 71° 55′.85

From the results at stations three and four, it appears that the needle was not influenced by the line of iron pipes, for such an influence would have given a less dip than at stations one and two, whereas a greater dip was in both cases obtained than that observed at either station one or station two.

Stations three and four are much below the level of one and two. The needles at those two stations being in closer proximity to the rocks forming the substratum here, a ferruginous sandstone, no doubt caused the great change of dip, by a slight change of position. The dip at these four stations is, indeed, in proportion to the depression of these stations, respectively, below a given horizontal plane. That is, the greatest dip is found at the least elevation above tide, and the least dip is found at the greatest elevation, and so on, in proportion to actual depression.

XVII. Baltimore—Fifth Station.—June 11th, 1841.

In the small observatory in the botanic garden of St. Mary's College. This observatory was erected for magnetic observations. It is built with copper nails, and there is no iron about it. Latitude 39° 17′ 55″, N.; longitude 76° 37′ 30″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	6*h*. 43*m*., A. M.	76°	71° 44′.71
N	16	7 04 "	77 .5	71° 33′.66
Dip, by thirty-two observations on needle No. 1, ...				71° 39′.18

NEEDLE No. 2.

N	16	7*h*. 20*m*., A. M.,	78°	71° 42′.43
S	16	7 39 "	80	71° 34′.7
Dip, by thirty-two observations on needle No. 2, ...				71° 38′.56
Dip, by sixty-four observations on needles Nos. 1 and 2, ...				71° 38′.87

A RECAPITULATION,

Showing the results of all the observations for the dip at the respective stations at Baltimore, on the 9th, 10th, and 11th of June, 1841.

1st. At station three hundred and sixty-three yards N. 5° E. of the Washington Monument, by a mean of one hundred and twenty-eight observations on needles Nos. 1 and 2, combined, June 9th and 10th, ... 71° 47′.24

2d. At station S. 47° W., and distant one hundred and sixty-one feet from the curb-stone which marks the south-west corner of Calvert and Reed Streets, in the city plan, by a mean of sixty-four observations on needles No. 1 and 2, combined, June 10th, 1841, ... 71° 32′

3d. At station S. 35 E., and two hundred and twelve feet from station No. 1, being forty-three feet north of line of iron pipes; by thirty-two observations, two series, on needle No. 1, June 10th, 1841, ... 71° 48′.2

4th. At station S. 8 E., and one hundred and eighty-one feet from station No. 2, being one hundred and thirty-seven feet south of line of iron pipes, by sixteen observations on needle No. 1, June 10, 1841, ... 71° 50′.7

5th. At the observatory in the botanic garden of St. Mary's College, by sixty-four observations on needles No. 1 and 2 combined, on the 11th of June, 1841, ... 71° 38.′87

Comparing the dip obtained by Professor Bache, at station No. 2, with two needles, on the 27th of August, 1840, namely, 71° 34′.4, with my result from sixty-four observations, on two needles, on the 10th of June, 1841, namely, 71° 32′, we have, for an elapsed time of nine and a half months, a diminution of 2′.4, which is very near what might be expected in that lapse of time; and hence the agreement of the results obtained by two different observers, with different instruments, serves to confirm the accuracy of both.

Professor Loomis observed the dip in the grove north of the Washington Monument, Baltimore, with a single needle, on the 25th of September, 1839, to be 71° 50′.3.* But the precise locality of his station is not given. This is to be regretted, because it precludes any correct comparison with the results of other observers, and other instruments, made at after periods, for the purpose of ascertaining the periodical variation in the dip. This grove is an extensive one, and it has been shown, by the observations here presented, that a very little change of position in this grove produces a very sensible change in the dip. My stations 1, 2, 3, and 4, are all within this grove, which extends north and east of the Washington Monument. It is very desirable that all localities for magnetic observations be stated with precision, in reference to permanent and conspicuous objects.

XVIII. OBSERVATIONS FOR THE DIP OF THE MAGNETIC NEEDLE, WITH INSTRUMENT BY GAMBEY, OF PARIS.

Date and place of observation.—1841, June 14th. At the magnetic Observatory of Girard College, Philadelphia.

No. of Needle	Polarity of Marked end of Needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads Deg. Mins. & Tenths.	South end of Needle reads Deg. Mins. & Tenths.	Mean of both ends of needle. Deg. Mins. & Tenths.	Attached Thermometer. (Fahrenheit.)	Name of Observer.
1	N	E	E	4.36 P.M.	72 . 01	72 . 00	72 . 00.5		A.D.B.
"	"	"	"		71 . 59	72 . 02	72 . 00.5	78°	J.D.G.
"	"	"	"		71 . 59	72 . 02	72 . 00.5		A.D.B.
"	"	E	W	4.50	71 . 22	71 . 26	71 . 24		J.D.G.
"	"	"	"		71 . 24	71 . 28	71 . 26	77.5	A.D.B.
"	"	"	"		71 . 24	71 . 28	71 . 26		J.D.G.
"	"	W	E	5.00	72 . 19	72 . 12	72 . 15.5		A.D.B.
"	"	"	"		72 . 20	72 . 13	72 . 16.5	75.5	J.D.G.
"	"	"	"		72 . 18	72 . 14	72 . 16		A.D.B.
"	"	W	W	5.12	71 . 46	71 . 39	71 . 42.5	74.2	J.D.G.
"	"	"	"		71 . 46	71 . 37	71 . 41.5		A.D.B.
"	"	"	"		71 . 46	71 . 39.5	71 . 42.7	74	J.D.G.
1	S	W	W	5.35	72 . 19	72 . 10	72 . 14.5	72.7	A.D.B.
"	"	"	"		72 . 19	72 . 13	72 . 16		J.D.G.
"	"	"	"		72 . 16	72 . 08	72 . 12		A.D.B.
"	"	W	E	5.52	72 . 04	71 . 57	72 . 00.5	71.5	J.D.G.
"	"	"	"		72 . 03	71 . 56	71 . 59.5		A.D.B.
"	"	"	"		72 . 03	71 . 58	72 . 00.5		J.D.G.
"	"	E	W	6.00	71 . 59.	72 . 03	72 . 01	71	A.D.B.
"	"	"	"		71 . 58	72 . 02	72 . 00		J.D.G.
"	"	"	"		71 . 59	72 . 03	72 . 01		A.D.B.
"	"	E	E	6.10	71 . 42	71 . 47	71 . 44.5	70	J.D.G.
"	"	"	"		71 . 39	71 . 45	71 . 42		A.D.B.
"	"	"	"	6.20	71 . 41	71 . 45	71 . 43		J.D.G.

* See Transactions of the American Philosophical Society, vol. vii., new series, page 108.

I was joined in the observations at this station by Professor Alexander D. Bache, President of Girard College. The needles were read by us alternately. The initials in the last column will show the observations made by each observer.

Raining all the time we were observing with needle No. 1.

Needle No. 1, gives, with marked end north, ... 71° 51′
with marked end south, ... 71° 59′.5
Dip, by forty-eight observations on needle No. 1, ... 71° 55′.25

1841, June 14th.—At the Magnetic Observatory of Girard College, Philadelphia.

No. of Needle.	Polarity of marked end of needle.	Face of Instrument.	Marked side of Needle.	Mean solar time of observation. H. M.	North end of Needle reads. Deg.	Mins. & Tenths.	South end of Needle reads. Deg	Mins. & Tenths	Mean of both ends of Needle. Deg.	Mins. & Tenths	Attached Thermometer. (Fahrenheit.)	Name of Observer
2	S	E	E	6 . 25 P.M.	72	. 00	72	. 05	72	. 02.5		J. D. G.
"	"	"	"		72	. 01	72	. 05	72	. 03	68°.5	A. D. B.
"	"	"	"		72	. 02.5	72	. 06	72	. 04.2		J. D G.
"	"	E	W	6 . 30	71	. 31	71	. 35	71	. 33		A. D. B.
"	"	"	"		71	. 27	71	. 32	71	. 29.5		J. D. G.
"	"	"	"		71	. 29	71	. 34	71	. 31.5		A. D. B.
"	"	W	E	6 . 34	72	. 20	72	. 14	72	. 17		J. D. G.
"	"	"	"		72	. 20	72	. 13	72	. 16.5		A. D. B.
"	"	"	"		72	. 20	72	. 13	72	. 16.5		J. D. G.
"	"	W	W	6 . 37	71	. 47	71	. 38	71	. 42.5		A. D. B.
"	"	"	"		71	. 44	71	. 37	71	. 40.5		J. D. G.
"	"	"	"		71	. 45	71	. 39	71	. 42		A. D. B.
2	N	W	W	6 . 57	72	. 21.5	72	. 14	72	. 17.7	68	J. D. G.
"	"	"	"		72	. 23	72	. 15	72	. 19		A. D. B.
"	"	"	"		72	. 23	72	. 15	72	. 19		J. D. G.
"	"	W	E	7 . 00	71	. 47	71	. 41	71	. 44		A. D. B.
"	"	"	"		71	. 47	71	. 40	71	. 43.5		J. D. G.
"	"	"	"		71	. 48	71	. 40	71	. 44		A. D. B.
"	"	E	W	7 . 05	72	. 03	72	. 07	72	. 05		J. D. G.
"	"	"	"		72	. 04	72	. 06	72	. 05		A. D. B.
"	"	"	"		72	. 02	72	. 06	72	. 04		J. D. G.
"	"	E	E	7 . 10	71	. 28	71	. 33	71	. 30.5	67.5	A. D. B.
"	"	"	"		71	. 27	71	. 32	71	. 29.5		J. D. G.
"	"	"	"		71	. 27	71	. 32	71	. 29.5		A. D. B.

Raining nearly all the time we were observing this day.

Needle No. 2, gives, with marked end north, ... 71° 54′.22
with marked end south, ... 71° 53′.22
Dip, by forty-eight observations on needle No. 2, ... 71° 53′.72
Dip, by forty-eight observations on needle No. 1, ... 71° 55′.25

Magnetic dip at the Magnetical Observatory of Girard College, Philadelphia, by ninety-six observations on needles Nos. 1 and 2, June 14, 1841, . . 71° 54′.48

XIX. Cambridge Observatory, Massachusetts.

Latitude 42° 22′ 21″.3, N.; Longitude 71° 07′ 37″.5, W.

The station occupied was the marble table usually occupied by the variation Transit belonging to the Magnetic Department of the Observatory. This is the temporary observatory used until the permanent establishment shall be constructed.

I was joined in these observations by Wm. C. Bond, Esq., Director of the Cambridge

Observatory. We read the needles alternately, and a mean of all the observations, as made by us both, is given in the several results.

The close coincidence which had been remarked in the results of the two needles of this instrument, and the great uniformity in the readings of both in the various positions assumed for a course of observations, determined us to observe, without intermission, for twenty-four consecutive hours, with a view not only to a close determination of the dip at this station, but also to ascertain its diurnal variation.

1841, JUNE 29th.—NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	24	8*h*. 49*m*., P.M.	82°.7	74° 20′.76
N	24	10 28 "	79 .9	74° 11′.12
Dip, by forty-eight observations on needle No. 1, ...				74° 15′.94

1841, JUNE 30.—NEEDLE No. 2.

N	24	1*h*. 35*m*., A.M.	78°.9	74° 16′.47
S	24	3 12 "	78 .8	74° 16′.11
Dip, by forty-eight observations on needle No. 2, ...				74° 16′.29

NEEDLE No. 2, REPEATED.

S	24	10*h*. 03*m*., A.M.	85°.5	74° 18′.82
N	24	11 14 "	88 .5	74° 23′.28
Dip, by forty-eight observations on needle No. 2, second set, . .				74° 21′.05

NEEDLE No. 1.

N	24	0*h*. 28*m*., P.M.	89°	74° 14′.65
S	24	1 38 "	92	74° 21′.86
Dip, by forty-eight observations on needle No. 1, second set, . .				74° 18′.25

NEEDLE No. 1, REPEATED.

S	24	3*h*. 18*m*., P.M.	87°.5	74° 23′.5
N	24	4 20 "	84	74° 09′.45
Dip, by forty-eight observations on needle No. 1, third set, . . .				74° 16′.42

NEEDLE No. 2.—JUNE 30.

N	24	5*h*. 02*m*., P.M.	83°.5	74° 18′.13
S	24	6 18 "	81	74° 13′.53
Dip, by forty-eight observations on needle No. 2, third set, . . .				74° 15′.83

RECAPITULATION OF THE FOREGOING OBSERVATIONS AT CAMBRIDGE.

Date—1841.	No. of Needle.	Polarity of marked end of Needle.	Beginning of observations on each needle.	End of observations on each needle.	Mean of each set of readings.	Dip by each needle.
June 29,	1	S	8*h*.13*m*., P.M.	9*h*.25*m*., P.M.	74° 20′.76	74° 15′.94
		N	9 55 "	11 00 "	74° 11′.12	
June 30,	2	N	1*h*.12*m*., A.M.	1*h*.58*m*., A.M.	74° 16′.47	74° 16′.29
		S	2 50 "	3 34 "	74° 16′.11	
June 30,	2	S	9*h*.45*m*., A.M.	10*h*.22*m*., A.M.	74° 18′.82	74° 21′.05
		N	10 58 "	11 31 "	74° 23′.28	
June 30,	1	N	0*h*.07*m*., P.M.	0*h*.48*m*., P.M.	74° 14′.65	74° 18′.25
		S	1 21 "	1 55 "	74° 21′.86	
June 30,	1	S	2*h*.52*m*., P.M.	3*h*.44*m*., P.M.	74° 23′.5	74° 16′.47
		N	4 03 "	4 37 "	74° 09′.45	
June 30,	2	N	4*h*.48*m*., P.M.	5*h*.17*m*., P.M.	74° 18′.13	74° 15′.83
		S	5 58 "	6 38 "	74° 15′.83	

Dip, by one hundred and forty-four observations on needle No. 1, made June the 29th and 30th, 1841, ... 74° 16′.88

Dip, by one hundred and forty-four observations on needle No. 2, made June 30th, 1841, ... 74° 17′.72

Magnetic dip, by a mean of two hundred and eighty-eight observations, including both needles, ... 74° 17′.3

NOTE.—A mean between the greatest and least dip obtained, being by two different needles, is 74° 18′.44.

A mean between both needles in the night, say from 8*h*. 13*m*., P. M., to 3*h*. 34*m*., A. M., the middle time being within seven minutes of midnight, is 74° 16′.11.

A mean between both needles in the day, say from 10*h*. 22*m*., A. M., to 1*h*. 55*m*., P. M., the middle time being eight minutes after noon, is 74° 19′.65.

A mean between the midnight and the mid-day results, as above, is 74° 17′.88.

XX. *Boston, July 2d*, 1841.

On the common or mall. The position of observation is two hundred and fifty feet east by south of the summit of the old redoubt, or battery hill, the instrument being under the shade of a small elm tree. Latitude 42° 21′ 19″, N.; Longitude 71° 04′ 12″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	24	7*h*. 13*m*., A. M.	68°	74° 03′.49
S	24	8 25 "	70	74° 13′.33

Dip, by forty-eight observations on needle No. 1, ... 74° 08′.41

NEEDLE No. 2.

S	24	9*h*. 29*m*., A. M.	70°.5	74° 08′.33
N	24	10 53 "	74	74° 12′.58

Dip, by forty-eight observations on needle No. 2, ... 74° 10′.45

Dip, by a mean of ninety-six observations on needles Nos. 1 and 2, . . . 74° 09′.43

XXI. *Bangor, Maine, July 9th*, 1841.

In the vacant lot of Mr. A. M. Roberts. Latitude 44° 48′, N.; Longitude 68° 47′, W.

NEEDLE No. 1.

S	24	1*h*. 35*m*., P. M.	75°.5	76° 17′.41
N	24	2 38 "	75	76° 09′.14

Dip, by forty-eight observations on needle No. 1, ... 76° 13′.27

NEEDLE No. 2.

N	24	6*h*. 10*m*., P. M.	67°.5	76° 11′.89
S	24	6 57 "	65	76° 09′.71

Dip, by forty-eight observations on needle No. 2, ... 76° 10′.8

NEEDLE No. 1, REPEATED.

N	16	7*h*. 51*m*., P. M.	62°.5	76° 09′.27
S	8	8 26 "	62	76° 13′.87

Dip, by twenty-four observations on needle No. 1, second trial, . 76° 11′.57

The late hour of the evening prevented more than eight readings on needle No. 1, with the polarity south, second set.

RECAPITULATION

Of the observations made at Bangor, Maine, July 9, 1841.

Magnetic dip, by forty-eight observations on needle No. 1, from 1*h.* 15*m.*, to 2*h.* 52*m.*, P.M., ... 76° 13′.27

Magnetic dip, by twelve observations on the same needle, from 7*h.* 43*m.*, to 8*h.* 35*m.*, P.M., ... 76° 11′.57

Dip, by sixty observations on needle No. 1, ... 76° 12′.4

" forty-eight observations on needle No. 2, ... 76° 10′.8

Dip, by a mean of one hundred and eight observations on needles Nos. 1 and 2, made July 9th, 1841, ... 76° 11′.6

The weather was clear all day.

A small white-oak tree marks the position of the instrument. From it the following magnetic bearings were observed, of conspicuous objects, viz.:

To the steeple of the new Methodist Church, distant about 250 yards, S. 74° W.

To the dome of the Female Academy, S. 53° W.

To the centre of the state arsenal, N. 4° W.

The three bearings fix the point of observation independent of a measured distance, which could not conveniently be made here.

XXII. *Park's Hill, August 27th*, 1841.

Astronomical station No. 2, on the true meridian of the monument at the source of the river St. Croix. Boundary of Maine and New Brunswick. Latitude 46° 06′ 40″, N.; Longitude 67° 46′ 45″, W. Same station as XI. in the preceding series.

NEEDLE No. 1.

Polarity of Marked end.	No of Readings.	Time of Observation.	Temperature.	Dip observed.
S	24	12*h.* 00*m.*, noon.	69°.5	77° 03′.82
N	24	00 51 A.M.	73 .5	76° 57′.74

Dip, by forty-eight observations on needle No. 1, ... 77° 00′.78

NEEDLE No. 2.

S	24	1*h.* 51*m.*, P.M.,	74°	76° 59′.29
N	24	2 48 "	75	77° 02′.14

Dip, by forty-eight observations on needle No. 2, ... 77° 00′.71

Dip, by a mean of ninety-six observations on needles Nos. 1 and 2, . . . 77° 00′.74

The observations were made in the shade of the forest: the sun somewhat obscured by thin clouds: weather pleasant: wind south south-east: nearly calm.

NOTE.—On the 27th, 28th, and 29th of November, 1840, I observed the dip at this station with the instrument by Troughton & Simms, of London, which I had used on the Texan frontier. The result then obtained, with the needles numbered 3 and 4, was 70° 02′.5, differing 1′.8 from the result obtained now, with the Gambey instrument, in an elapsed period of nine months. See observation XI. of my preceding series.

The difference of these two results is probably not more than should be attributed to the diminution of the dip during the elapsed time between the two sets of observations, being at the rate of 2′.4 per annum. The results show a very satisfactory agreement in the two instruments, and seem to entitle the observations made on the Texan frontier and elsewhere, with the former instrument, to additional weight in regard to accuracy.

XXIII. *Blue Hill, New Brunswick.* 1841, *October 5th and 6th.*

At astronomical station No. 3, on the meridian of the monument at the source of the river St. Croix. Latitude 46° 38′, N.; Longitude 67° 46′ 45″, W.

NEEDLE No. 1.—OCTOBER 5.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	4*h*. 11*m*., P.M.	47°	77° 15′.83
S	16	4 56 "	44	77° 19′.18

Dip, by thirty-two observations on needle No. 1, ... 77° 17′.5

NEEDLE No. 2.—OCTOBER 5TH AND 6TH.

N	16	5*h*. 30*m*., P.M., Oct. 5	44°	77° 20′.5
S	16	10 59 A.M., Oct. 6	54	77° 17′.5

Dip, by thirty-two observations on needle No. 2, October 5th, P.M., and October 6th, A.M., ... 77° 19′

NEEDLE No. 2 AS OBSERVED ON WHOLLY ON THE 6TH OF OCTOBER.

S	16	10*h*. 59*m*. A.M.	54°	77° 17′.5
N	16	11 51 "	60	77° 19′.56

Dip, by thirty-two observations on needle No. 2, October 6th, . . 77° 18′.53

RECAPITULATION.

Dip, by thirty-two observations on needle No. 1, October 5th, 1841, . . 77° 17′.5
Dip, by forty-eight observations on needle No. 2, made on the 5th and 6th of October, 1841, ... 77° 18′.76
Dip, by eighty observations on needles Nos. 1 and 2, made October 5th and 6th, giving an equal weight to each needle, ... 77° 18′.1

XXIV. *Aroostook Hill, New Brunswick.* 1841, *October 29th.*

At astronomical station No. 4, on the true meridian of the monument at the source of the river St. Croix. Latitude 46° 47′, N.; Longitude 67° 46′ 45″, W.

NEEDLE No. 1.

S	16	2*h*. 23*m*., P.M.	34°	77° 27′.62
N	16	3 20 "	35	77° 22′.12

Dip, by thirty-two observations on needle No. 1, ... 77° 24′.87

NEEDLE No. 2.

N	16	3*h*. 40*m*., P.M.	35°	77° 23′.37
S	16	4 06 "	34 .5	77° 23′.37

Dip, by thirty-two observations on needle No. 2, ... 77° 23′.37
Dip, by sixty-four observations on needles Nos. 1 and 2, ... 77° 24′.1

Cloudy, and sometimes raining during the observations. Wind south and squally. A few flakes of snow fell before the observations were begun.

XXV. *Peconk Hill, New Brunswick.*

At astronomical station No. 5, on the meridian of the monument at the source of the river St. Croix. Latitude 46° 59′ 25″, N.; Longitude 67° 46′ 45″, W. 1841, November 28th.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	0*h.* 06*m.*, P. M.	26°	77° 30′.68
S	16	1 00 "	25 .5	77° 34′.81

Dip, by thirty-two observations on needle No. 1, ... 77° 32′.75

The wind north-east. The sky tolerably clear when needle No. 1 was observed on.

NEEDLE No. 2.

S	16	2*h.* 15*m.*, P. M.	25°	77° 30′.65
N	16	3 11 "	24 .5	77° 32′.56

Dip, by thirty-two observations on needle No. 2, ... 77° 31′.6

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 32′.17

A light north-east wind, and snowing a little when needle No. 2 was observed on. The observations were made under a tent, free from iron fixtures.

XXVI. *Grand Falls of the St. John, New Brunswick.*

Latitude 47° 02′ 48″.5, N.; Longitude 67° 44′ 36″, W. 1843, September 10th.

NEEDLE No. 1.

N	16	1*h.* 02*m.*, P. M.	57°	77° 28′.3
S	16	2 01 "	59	77° 33′.6

Dip, by thirty-two observations on needle No. 1, ... 77° 30′.9

NEEDLE No. 2.

N	16	3*h.* 03*m.*, P. M.	57°	77° 29′.6
S	16	4 10 "	60	77° 26′.7

Dip, by thirty-two observations on needle No. 2, ... 77° 28′.1

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 77° 29′.5

The weather was clear and dry all day. A fresh south-west wind. Observed under a tent free from iron fixtures.

XXVII. *At the point of intersection of the north shore of the River St. John with the meridian of the monument at the source of the River St. Croix, as traced by Major Graham in* 1840 *and* 1841.

Latitude 47° 03′ 47″, N.; Longitude 67° 46′ 45″, W. 1843, September 11th.

NEEDLE No. 1.

S	16	11*h.* 57*m.*, A. M.	67°	77° 34′.33
N	16	0 45 P. M.	65 .5	77° 29′.97

Dip, by thirty-two observations on needle No. 1, ... 77° 32′.15

NEEDLE No. 2.

S	16	1*h.* 37*m.*, P. M.	65°.5	77° 29′.3
N	16	2 21 "	65	77° 30′.6

Dip, by thirty-two observations on needle No. 2. . . . . 77° 29′.95

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 77° 31′.05

XXVIII. *At the Inn of Anselme Albert, (late the Widow Michean's,) south bank of the River St. John, Maine.*

Latitude 47° 17′ 20″, N.; Longitude 68° 27′ 34″, W. 1843,—September 16th and 17th.

NEEDLE No. 1—SEPTEMBER 16TH.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed
N	16	5*h*. 23*m*. P.M.	71°	77° 43′.5
S	16	6 04 "	67 .5	77° 47′.3

Dip by thirty-two observations on needle No. 1, ... 77° 45′.4

NEEDLE No. 2,—SEPTEMBER 17TH.

N	16	11*h*. 31*m*. A.M.	68°	77° 45′.19
S	16	0 29 P.M.	65	77° 42′.21

Dip, by thirty-two observations on needle No. 2, ... 77° 43′.7

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 77° 44′.5

NOTE.—The point of observation is six hundred and five feet below the front door of Anselme Albert's Inn, measured along the crest of the high bank of the river St. John, on a magnetic course of S. 20° E.

The weather was clear during the observations on needle No. 1, on the 16th. During the observations on needle No. 2, on the seventeenth, it was frequently raining. Sky entirely overcast with clouds all this day. Nearly calm.

XXIX. *Mouth of Fish River, Maine, military post of Fort Kent.*

Latitude 47° 15′ 14″.5, N.; Longitude 68° 35′ 30″, W. 1843,—September 18th.

NEEDLE No. 1.

S	16	1*h*. 25*m*., P.M.	78°.5	77° 45′.55
N	16	2 10 "	77 .5	77° 41′.81

Dip, by thirty-two observations on needle No. 1, ... 77° 43′.68

NEEDLE No. 2.

S	16	3*h*. 14*m*., P.M.	82°5	77° 42′
N	16	3 52 "	81	77° 43′.06

Dip, by thirty-two observations on needle No. 2, ... 77° 42′.53

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 77° 43′.1

Weather fair. A fresh breeze from the north-west.

NOTE.—The point of observation is immediately on the high bank of Fish River, and fifty feet above the extreme point of the angle formed by the junction of the left or western bank of Fish River, with the right or southern shore of the River St. John.

From this point to the north-west corner of the Block House of Fort Kent is S. 8° W., magnetic, and the distance is four hundred and eleven feet, by measurement.

XXX. 1843,—*September 26th. Mouth of St. Francis River.*

At astronomical station of 1842, near Hammond's barn, New Brunswick. Latitude 47° 10′ 57″.9, N.; Longitude 68° 53′ 58″.5, W.

NEEDLE No. 1.

N	16	0*h*. 06*m*., P.M.	54°	77° 43′.19
S	16	0 51 P.M.	58 .5	77° 45′.21

Dip, by thirty-two observations on needle No. 1, ... 77° 44′.20

NEEDLE No. 2.

Polarity of Marked end of Needle.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	1*h.* 53*m.*, P. M.	55°.5	77° 44′.46
S	16	2 40 "	57 .5	77° 41′.09

Dip, by thirty-two observations on needle No. 2, ... 77° 42′.77

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 43′.48

In the observations of this station I was joined by Captain William Robinson of the Royal Engineers, British astronomer attached to the joint commission for the demarcation of the boundary under the treaty of Washington. We read the needles alternately, and the final result is a mean of our respective readings.

Slight rain, with occasional sunshine during the observations.

XXXI. 1843,—*October 2d. At the head of Lake Petteiquaggamac or Beau Lac, of the St. Francis River, Maine.*

The position of the instrument is immediately on the right bank of the river, near its entrance into this lake, and N. 55° E., by needle, and two hundred and five feet from the astronomical station of last year, at the head of this lake. Latitude 47° 22′ 40″, N.; Longitude 69° 03′ 21″, W.

NEEDLE No. 1.

S	16	9*h.* 22*m.*, A. M.,	49°	77° 47′.93
N	16	10 21 "	49	77° 45′.8

Dip, by thirty-two observations on needle No. 1, ... 77° 46′.85

NEEDLE No. 2.

S	16	11*h.* 39*m.*, A. M.	48°.5	77° 46′.15
N	16	0 33 P. M.	49	77° 48′.34

Dip, by thirty-two observations on needle No. 2, ... 77° 47′.2

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 47′

Wind north-east and squally; raining during the observations. The instrument was well protected, by a good water-proof tent, free from any iron fixtures.

XXXII. 1843,—*October 4th. At the outlet of Lake Pohenagamook.*

At astronomical station No. 13, of the year 1842. Maine and Canada boundary Latitude 47° 27′ 33″.5, N.; Longitude 69° 13′ 19″, W.

NEEDLE No. 1.

N	16	10*h.* 28*m.*, A. M.	48°	77° 47′.53
S	16	11 18 "	49 .5	77° 51′.53

Dip, by thirty-two observations on needle No. 1, ... 77° 49′.53

NEEDLE No. 2.

N	16	11*h.* 55*m.*, A. M.	52°	77° 50′.97
S	16	0 42 "	49 .5	77° 47′.00

Dip, by thirty-two observations on needle No. 2, ... 77° 48′.98

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 49′.2

Cloudy, with frequent showers of rain. Wind north-west, fresh

XXXIII. 1843,—*October 10th. Mouth of the Chimpassaooctuc, or Big Black River, a tributary of the River St. John, Maine.*

The point of observation is astronomical station No. 18, on a small island of the river St. John, opposite to the mouth of Big Black River. Latitude 46° 57′, N.; Longitude 69° 26′ 46″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	11*h*. 57*m*., A. M.	59°	77° 39′.22
N	16	0 48 P. M.	58 .5	77° 35′.12

Dip, by thirty-two observations on needle No. 1, ... 77° 37′.17

NEEDLE No. 2.

S	16	1*h*. 25*m*., P. M.	59°	77° 36′.56
N	16	2 15 "	58 .5	77° 39′.12

Dip, by a mean of thirty-two observations on needle No. 2, . . 77° 37′.84

Dip, by a mean of sixty-four observations on needles No. 1 and 2, . 77° 37′.5

Cloudy, and occasionally a sprinkle of rain. Wind easterly and light.

XXXIV. 1843,—*October 17th. Near the Grand Forks of the River St. John.*

The point of observation is the astronomical station, where the line of ten miles, measured in the shortest direction from the North-West Branch, touches the river St. John. Latitude 46° 34′ 37″, N.; Longitude 69° 53′ 00″, W.

NEEDLE No. 1.

N	16	0*h*. 17*m*., P. M.	51°.5	77° 23′.43
S	16	1 15 "	50	77° 28′.15

Dip, by thirty-two observations on needle No. 1, ... 77° 25′.79

NEEDLE No. 2.

N	16	2*h*. 02*m*., P. M.	48°.5	77° 26′.34
S	16	2 51 "	47 .5	77° 25′.84

Dip, by thirty-two observations on needle No. 2, ... 77° 26′.09

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 25′.94

Cloudy. Occasional sunshine during the observations. Wind westerly.

XXXV. *October 29th*, 1843. *At the mouth of the Madawaska River, a tributary of the St. John, New Brunswick.*

Latitude 47° 21′ 39″, N.; Longitude 68° 19′ 25″, W.

NEEDLE No. 1.

S	16	1*h*. 32*m*., P. M.	50°.5	77° 48′.34
N	16	2 32 "	44 .5	77° 46′.15

Dip, by thirty-two observations on needle No. 1, ... 77° 47′.24

NEEDLE No. 2.

S	16	2*h*. 59*m*., P. M.	43°	77° 45′.25
N	16	4 44 "	40 .5	77° 50′.18

Dip, by thirty-two observations on needle No. 2, ... 77° 47′.71

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 77° 47′.47

Cloudy; wind north-east; nearly calm. Light rain and mist during part of the observations on needle No. 2.

The point of observation is the intersection of the eastern shore of the Madawaska with the north shore of the St. John River.

XXXVI. 1844,—*May 2d. Portsmouth, New Hampshire.*

On Jamaica Island, near its north-western shore, in the hay-field of Mr. Isaias Preble. Latitude 43° 04′ 56″, N.; Longitude 70° 43′ 56″, W.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	0*h.* 16*m.*, P.M.	73°.5	74° 49′.62
N	16	0 59 "	74	74° 45′.59

Dip by thirty-two observations on needle No. 1, ... 74° 47′.6

NEEDLE No. 2.

S	16	1*h.* 42*m.*, P.M.	72°.5	74° 47′.93
N	16	2 21 "	73	74° 47′.53

Dip, by thirty-two observations on needle No. 2, ... 74° 47′.73

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 74° 47′.66

Sky somewhat overcast. Fresh breeze from west-south-west.

NOTE.—In the observations at this and the succeeding four stations at and near Portsmouth, I was assisted by Lieutenant Whipple, of the Corps of Topographical Engineers attached to the survey for the defences of the harbour. I am indebted to him for the latitudes and longitudes of the actual positions of observation, which were derived by him from an accurate triangulation made to connect them all, in latitude and longitude, with the Unitarian stone Church, whose position was taken as given in the American Almanac, as in latitude 43° 04′ 35″, N.; and longitude 70° 45′ 50″, W. of Greenwich.

XXXVII. 1844,—*May 2d. Portsmouth, New Hampshire.*

The point of observation is eighty feet on a magnetic course of S. 68° 30′ W. from the northern extremity of Captain Stansbury's base line for the trigonometrical survey of the harbour of Portsmouth, and is in Latitude 43° 02′ 59″, N.; Longitude 70° 43′ 36″, W.

NEEDLE No. 1.

N	16	5*h.* 03*m.*, P.M.	75°.5	74° 35′.25
S	16	5 32 "	73 .5	74° 39′.48

Dip, by thirty-two observations on needle No. 1, ... 74° 37′.36

NEEDLE No. 2.

N	16	5*h.* 52*m.*, P.M.	73°	74° 38′.97
S	16	6 15 "	72	74° 38′.43

Dip, by thirty-two observations on needle No. 2, ... 74° 38′.7

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . 74° 38′.03

Weather fair. Strong wind from the west-south-west.

XXXVIII. 1844,—*May 3d. Portsmouth, New Hampshire.*

The point of observation is in Mr. Robert Shelliby's pasture field. The instrument stands on a knoll twenty paces from a lonely black wild cherry tree, two feet in diameter

at its base. From this point the house of the Hon. Levi Woodbury is about three hundred feet in a north-easterly direction. Latitude 43° 04′ 27″, N.; Longitude 70° 46′ 36″, W

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed
S	16	11*h*. 18*m*., A. M.	80°	74° 57′.15
N	16	11 49 "	79	74° 53′.28

Dip, by thirty-two observations on needle No. 1, ... 74° 55′.21

NEEDLE No. 2.

S	16	0*h*. 14*m*., P. M.	78°	74° 52′.03
N	16	0 43 "	78	74° 52′.34

Dip, by thirty-two observations on needle No. 2, ... 74° 52′.18

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 74° 53′.7

Weather clear and pleasant. A fresh south-west wind.

XXXIX. *May* 3*d*, 1844.—*Portsmouth, New Hampshire.*

On Shapley's Point, being the southern extremity of Shapley's Island, four paces west of the trigonometrical station on this island. Latitude 43° 04′ 10″.5, N.; Longitude 70° 44′ 48″, W.

NEEDLE No. 1.

N	16	3*h*. 02*m*., P. M.	67°	74° 55′.43
S	16	3 32 "	66	74° 60′.31

Dip, by thirty-two observations on needle No. 1, ... 74° 57′.87

NEEDLE No. 2.

N	16	4*h*. 02*m*., P. M.	66°	74° 59′.90
S	16	4 32 "	66	74° 57′.15

Dip, by thirty-two observations on needle No. 2, ... 74° 58′.52

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 74° 58′.2

Weather clear and pleasant. Strong south-west breeze.

XL. *May* 4*th*, 1844.—*Portsmouth, New Hampshire.*

On "One Tree Island," a small island about one-fourth of an acre in area, opposite to Union Wharf. Latitude 43° 04′ 40″, N.; Longitude 70° 45′ 17″, W.

NOTE.—This is a very eligible position for magnetic observations, being very accessible from the city, and remote from any apparent cause of disturbance of the needle.

NEEDLE No. 1.

S	16	0*h*. 50*m*., P. M.	59°.5	74° 58′.68
N	16	1 28 "	57	74° 56′.28

Dip, by thirty-two observations on needle No. 1, ... 74° 57′.48

NEEDLE No. 2.

S	16	2*h*. 01*m*., P. M.	55°.5	74° 53′.68
N	16	2 35 "	56	74° 60′.87

Dip, by thirty-two observations on needle No. 2, ... 74° 57′.27

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, . . . 74° 57′.37

Weather clear and pleasant. A moderate south-west breeze.

All the observations at Portsmouth were made under a tent, with fixtures devoid of iron.

XLI. *May* 10*th*, 1844.—*Philadelphia.*

Rittenhouse Square. The position of the instrument is the most western point of the circular gravelled walk which surrounds the centre grass plat of this square. A wooden fence at this time encloses the square. At the centre point of the square is an iron water pipe and plug which obliged me to occupy a point without its influence upon the needles. Latitude 39° 56′ 59″; Longitude 75° 10′ 43″.5.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	6*h*. 57*m*., A. M.	57°	72° 06′
S	16	7 47 "	62	72° 10′

Dip, by thirty-two observations on needle No. 1, ... 72° 08′

NEEDLE No. 2.

N	16	8*h*. 58*m*., A. M.	62°.5	72° 11′.12
S	16	9 38 "	64 .5	72° 09′.75

Dip, by thirty-two observations on needle No. 2, ... 72° 10′.43

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 72° 09′.2

Weather clear and pleasant, with a gentle easterly breeze during the observations. The instrument was well shaded by trees.

NOTE.—This square affords a very eligible position for magnetic observations. Its centre is sufficiently remote from buildings and all cause of extraneous influence upon the needles. The trees within the square afford good shade for the instrument, and if the observer choose an early hour of the morning for his observations, there is no danger of any interruption from a crowd.

XLII. 1844, *July* 8*th*.—*Washington City, District of Columbia.*

Near the centre of the public garden, immediately east of the capitol. This is the same station as XII., where I observed the dip with the same instrument and needles on the 1st, 4th, and 5th of June, 1841. Latitude 38° 53′ 30″, N.; Longitude 77° 01′ 30″, W.

NEEDLE No. 1.

S	16	6*h*. 23*m*., A. M.	66°	71° 13′.34
N	16	7 17 "	70	71° 09′.15

Dip, by thirty-two observations on needle No. 1, ... 71° 11′.24

NEEDLE No. 2.

S	16	8*h*. 05*m*., A. M.	74°	71° 06′.28
N	16	8 56 "	76	71° 13′.47

Dip, by thirty-two observations on needle No. 2, ... 71° 09′.87

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 71° 10′.55

Weather fair and pleasant. A very gentle wind from east-north-east.

The dip, by a mean of one hundred and ninety-two observations, with this instrument, using the same needles as now, was observed on the 1st, 4th, and 5th of June, 1841, by Mr. J. N. Nicollet and myself to be 71° 15′.9, Mr. Nicollet having joined in those of

the 4th. And the dip obtained by Mr. Nicollet with his instrument, by Robinson of London, from a mean of one hundred and twenty observations, made on the 5th of June, 1841, was 71° 15′.4. Giving value to the observations of that period in proportion to the number of observations made with each instrument, we may state the dip at Washington, June 1st to 5th, 1841, to be, 71° 15′.7, and at the same place, on July 8th, 1844, 71° 10′.5. Decrease, in three and one-tenth years, 5′.2, or at the rate of 1′.67 per annum.

XLIII. 1844, *July 15th.—Baltimore.*

At the second Baltimore station, in the series of the year 1841; namely, one hundred and sixty-one feet on a magnetic course of S. 47° W. from the curb-stone which marks the south-west corner of Calvert and Reed Streets.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	2*h.* 12*m.*, P. M.	88°.5	71° 29′.5
S	16	2 52 "	89	71° 35′.9

Dip, by thirty-two observations on needle No. 1, ... 71° 32′.7

NEEDLE No. 2.

N	16	3*h.* 43*m.*, P. M.	89°	71° 35′.84
S	16	4 23 "	88 .5	71° 28′.93

Dip, by thirty-two observations on needle No. 2, ... 71° 32′.38

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 71° 32′.54

Weather clear. A gentle southerly breeze.

I obtained, for the dip at this station, by sixty-four observations on the same needles, with the same instrument, on June 10th, 1841, 71° 32′. See No. XIV. (page 354.)

Both sets of observations were quite satisfactory, and all the circumstances under which the two sets were made were equally favourable, and very similar. The temperature was nearly the same, so that no sensible correction is due, on that ground, to either set, for comparing it with the other. The difference in the dip obtained after a lapse of three years and thirty-six days, is only half a minute at this station, and the more recent observations give the greater dip. This may seem anomalous, but I have no reason to doubt the accuracy of either of the results. No buildings have been erected near the station since the first observations were made, nor is there any visible change of local circumstance whatever, that could have affected the dip.

XLIV. 1844, *July 16th.—Baltimore.*

Observatory of St. Mary's College, being the same station as No. XVII. Latitude 39° 17′ 55″, N.; Longitude 76° 37′ 30″, W.

NEEDLE No. 1.

S	16	8*h.* 12*m.*, A. M.	83°	71° 42′.75
N	16	8 44 "	85	71° 36′.51

Dip, by thirty-two observations on needle No. 1, ... 71° 39′.63

NEEDLE No. 2.

Polarity of Marked end.	No of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	9*h.* 09*m.*, A. M.	86°.5	71° 36′.12
N	16	9 42 "	88	71° 42′.81

Dip, by thirty-two observations on needle No. 2, ... 71° 39′.46

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 71° 39′.54

Weather clear and pleasant.

I obtained, for the dip at this station, by sixty-four observations on the same needles, and with the same apparatus in all respects, on June 11th, 1841, 71° 38′.87. See No. XVII., page 356.

Here again, at another station within the same city, the increase of dip, during a lapse of three years and thirty-six days, seems only to have amounted to two-thirds of a minute. No circumstance attending the observations nor change of local circumstance as respects the station, since the first observations were made, could be perceived, that could affect the dip.

XLV. 1844, *July 22d.—City of New York.*

Centre of Washington Square.

NEEDLE No. 1.

N	16	6*h.* 01*m.*, A.M.	67°	72° 29′.62
S	16	7 15 "	71	72° 32′.34

Dip, by thirty-two observations on needle No. 1, ... 72° 30′.98

NEEDLE No. 2.

N	16	8*h.* 17*m.*, A.M.	74°	72° 29′.75
S	16	9 15 "	77 .5	72° 23′.84

Dip, by thirty-two observations on needle No. 2. . . . . 72° 26′.79

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 72° 28′.88

Weather clear and dry. A very gentle breeze from the west.

The length of time occupied in these observations was owing to interruptions from idle spectators. Care was taken not to read the needles whilst any one was near enough to them to affect them, in case there was metal about his person, such as knives, keys, &c.

XLVI. 1844, *August 5th.—Forks of the Kennebec, Maine.*

Latitude of point of observation 45° 20′ 03″, N.; Longitude 69° 58′ 16″, W.

NEEDLE No. 1.

S	16	6*h.* 32*m.*, P.M.	67°	76° 23′.78
N	16	7 05 "	61 .5	76° 22′.78

Dip, by thirty-two observations on needle No. 1, ... 76° 23′.28

NEEDLE No. 2.

S	16	7*h.* 33*m.* P.M.	58°	76° 22′.94
N	16	8 00 "	55 .5	76° 25′.40

Dip, by thirty-two observations on needle No. 2, ... 76° 24′.17

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 76° 23′.7

Weather clear and calm.

NOTE.—From the front door of Burnham's Inn, near the east end of the bridge above the forks of the Kennebec river, to the point of observation, is S. 25° W., compared with the true meridian, or S. 38° W., magnetic, and the distance, by measurement, four hundred and ninety feet.

XLVII. 1844,—*August 7th.—Taschereau's. Intersection of the Highland Boundary with the Quebec road. Maine and Canada line.*

Latitude of point of observation N. 45° 48′ 37″.7; Longitude of do. W. 70° 24′ 07″.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
N	16	6*h.* 08*m.*, P. M.	56°	76° 48′.44
S	16	6 39 "	58	76° 51′.12

Dip, by thirty-two observations on needle No. 1, ... 76° 49′.78

NEEDLE No. 2.

N	16	6*h.* 55*m.*, P. M.	58°	76° 52′.56
S	16	7 34 "	56	76° 49′.59

Dip, by thirty-two observations on needle No. 2, ... 77° 51′.07

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 76° 50′.42

Raining, during the observations on both needles. The instrument was protected by a tent, free from any iron fixtures.

NOTE.—The point of observation is on the summit of the ridge of Highlands, and bears, from the front door of Taschereau's house, by the magnetic needle, N. 57° 30′ E., and is distant, by measurement, three hundred and twenty-five feet.

XLVIII. 1844,—*August 11th. Moose River Post Office, Maine.*

Latitude of point of observation 45° 39′ 22″, N.; Longitude 70° 16′ 08″, W.

NEEDLE No. 1.

S	16	6*h.* 28*m.*, A. M.	55°.5	76° 50′.3
N	16	7 16 "	57	76° 47′.5

Dip, by thirty-two observations on needle No. 1, ... 76° 48′.9

NEEDLE No. 2.

S	16	7*h.* 33*m.*, A. M.	57°	76° 46′.5
N	16	8 00 "	57	76° 49′.93

Dip, by thirty-two observations on needle No. 2, ... 76° 48′.2

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 76° 48′.5

The morning was clear and dry, with a stiff west breeze.

NOTE.—The point of observation is in the hay-field of Mr. Jacob Lowell, on the hill north-east of his house, and about ninety yards to the east of the public road. From the point of observation to the south-east corner of Mr. J. Lowell's house is S. 28° W., by needle, and the distance, by measurement, is six hundred and sixty-four feet.

XLIX. 1844, *September 1st.—Mouth of Grand River, New Brunswick.*

Latitude 47° 11′ 04″, N.; Longitude 67° 57′ 18″, W. The point of observation is the astronomical station at the mouth of the river, and is the north-east point of land at the junction of the east shore of Grand River with the north shore of the St. John

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed
N	16	9*h*. 56*m*., A. M.	70°	77° 37′.03
S	16	10 30 "	75	77° 39′.16

Dip, by thirty-two observations on needle No. 1, ... 77° 38′.10

NEEDLE No. 2.

N	16	10*h*. 48*m*., A. M.	79°.5	77° 41′.12
S	16	11 23 "	82	77° 36′.12

Dip, by thirty-two observations on needle No. 2, ... 77° 38′.62

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 77° 38′.36

Weather clear.

L. 1844, *September 5th.—Mouth of Little Black River, Maine.*

Latitude 47° 06′ 58″, N.; Longitude 69° 05′ 27″, W. The station is the same as the astronomical station of 1843 and 1844, and is at the extremity of the point of land formed by the junction of the eastern shore of Little Black River with the north shore of the river St. John.

NEEDLE No. 1.

S	16	3*h*. 54*m*., P. M.	75°.5	77° 42′.53
N	16	4 24 "	71 .5	77° 37′.97

Dip by thirty-two observations on needle No. 1, ... 77° 40′.25

NEEDLE No. 2.

S	16	4*h*. 44*m*., P. M.	71°	77° 38′.53
N	16	5 17 "	72	77° 42′.97

Dip, by thirty-two observations on needle No. 2, ... 77° 40′.75

Dip, by a mean of sixty-four observations on needles Nos. 1 and 2, ... 77° 40′.5

Weather clear and dry, with a gentle north-west wind.

LI. 1844, *November 9th.—South-west Branch of the St. John.*

At its intersection with the straight line of boundary. Maine and Canada line. Latitude 46° 25′ 00″, N.; Longitude 70° 03′ 45″, W.

NEEDLE No. 1.

N	16	9*h*. 34*m*., A. M.	32°.5	77° 23′.5
S	16	10 10 "	33 .5	77° 26′.03

Dip, by thirty-two observations on needle No. 1, ... 77° 24′.76

There was not time to make a satisfactory set of observations on needle No. 2. When the above were finished we left this station.

Weather cloudy. Occasionally a slight fall of snow. The snow is now two feet deep upon the ground.

The instrument was placed on the stand, (the trunk of a tree sunk four feet into the ground,) lately occupied by the altitude and azimuth instrument used for determining the latitude of this position, over which was a tent free from iron in any shape.

LII. *Cambridge Observatory, Massachusetts.*

Erected in the year 1844. Latitude 42° 22′ 48″.6, N.; Longitude 71° 08′ 00″, W The point of observation is within the small magnetic pavilion attached to this observatory.

The position is not the same as is reported under the No. XIX., (see page 357,) where observations were made of the dip by Mr. W. C. Bond and myself, with the same apparatus, on the 29th and 30th of June, 1841. The position occupied for those observations was the *temporary* observatory at Cambridge, in latitude 42° 22′ 21″.3, N.; and longitude 71° 07′ 37″.5, W., which was used both for astronomical and magnetic purposes, previous to the construction of the present permanent establishment. The change of position seems to have caused but a slight change in the dip.

I regretted that other duties prevented Mr. Bond from joining me in the observations, with this instrument, on the present occasion. I am, however, much indebted to him for having, very kindly, placed at my disposal all the necessary conveniences of the observatory.—1844, December 23d.

NEEDLE No. 1.

Polarity of Marked end.	No. of Readings.	Time of Observation.	Temperature.	Dip observed.
S	16	1*h*. 00*m*. P.M.	45°	74° 19′.2
N	16	1 56 "	44	74° 16′

Dip by thirty-two observations on needle No. 1, ... 74° 17′.6

NEEDLE No. 2.

S	16	3*h*. 20*m*. P.M.	43°	74° 18′.6
N	16	4 20 "	43	74° 19′

Dip, by thirty-two observations on needle No. 2, ... 74° 18′.8

Dip, by sixty-four observations on needles Nos. 1 and 2, ... 74° 18′.2

Foggy, and nearly calm, during the observations on needle No. 1.

Fog and rain, during the observations on needle No. 2. Wind from north-east.

Barometer 28.89 inches, being very low for this locality.

J. D. GRAHAM.

Continuation of Major Graham's Paper. Read April 17th, 1846

The following table (A) exhibits the results of the observations made at Rouse's Point, state of New York, on the 15th, 16th, 17th, and 18th of October, 1845, by Major Graham and Lieutenant Whipple, of the United States Corps of Topographical Engineers, for the dip of the magnetic needle, in the plane of the magnetic meridian, and in different azimuths.

The instrument used was made by Gambey of Paris, and has already been described.

The object of these observations was to test the accuracy of form of the axles of the needles, the freedom of the dip-circle from magnetism and ferruginous matter, and to ascertain the true dip from the observations made with the plane of the dip-circle, both in and out of the magnetic meridian.

In this table, column ten shows the equivalent dip for the plane of the magnetic meridian, deduced from each azimuthal observation, by the formula

$$\text{Cotan. } \delta = \frac{\text{Cotan. } \delta'}{\text{Cosin } \theta,}$$

In which θ represents the azimuth observed in, δ' the dip observed in said azimuth, and δ the equivalent dip when reduced to the plane of the magnetic meridian.

The several values of δ, thus deduced, are compared directly with the dip as it was actually observed in the plane of the magnetic meridian, by means of ninety-six observations on the two needles, which give 76° 40′.419 for the dip.

Inasmuch, however, as a very small error of observation at a large azimuth, (say at 60°, 70°, or 80° from the plane of the magnetic meridian,) would make a great difference in the value of δ as derived from computation, and thus show a discrepancy due, not to the form of the axle or to magnetism in the circle, but to the error of reading the needle combined with any small error that might exist in the division of the azimuthal circle, or in setting the vernier to the stated azimuth, it has been thought proper to institute likewise a comparison between the dips, as actually observed in the various azimuths, and the computed azimuthal dips, assuming δ to be equal to the dip actually observed in the plane of the magnetic meridian.

Hence, δ' *observed*, column seven, is compared directly with δ'', column eight, computed by transposing the terms of the formula so as to make

$$\text{Cotan. } \delta'' = \text{Cotan. } \delta. \text{ Cosin } \theta.$$

Column nine shows the difference in *minutes* and *decimals of minutes*, + or −, between δ' and δ'' for each azimuth observed in, and the quantities in this ninth column are considered as exhibiting a truer index of the accuracy of form of the axles of the needles than would be derived from a comparison of the several deduced values of δ contained in column ten.

A

LIII. *Observations on the Dip of the magnetic needle made in the plane of the magnetic meridian, and also in various azimuths, at every 10°, from 0° to 90°, (by turning the vernier of the upper azimuth plate from the magnetic north round to the magnetic west,) made with Major Graham's dip instrument, by Gambey of Paris.*

STATION.—The astronomical observatory of the Boundary Survey, at Rouse's Point, state of New York, in Latitude 45° 00′ 28″, N.; Longitude 4*h*. 53*m*. 25*s*. west of Greenwich.

OBSERVERS.—Major J. D. Graham and Lieutenant A. W. Whipple, United States Corps of Topographical Engineers.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date.	Mean solar time of observation.	Magnetic azimuth of plane of dip-circle.	No. of Needle.	Polarity of marked end of needle.	Dip observed in azimuth by each needle.	Dip in azimuth by observation.	Computed dip in azimuth.	Excess of computed over observed dip in various azimuths.	Dip reduced to plane of the magnetic meridian by each needle.	No. of observations.	Thermometer.	Barometer.	Remarks.
1845.												IN.	
Oct.15,	0*h*.38*m*., P.M.	0°&180°	1	N	76°39′.43	76°39′.998			76° 39′.998	32	43°.1	30.216	Weather clear and a stiff N.W wind during the observations on both needles on the 15th.
				S	76°40′.56								
" "	1*h*.44*m*., P.M.	0°&180°	2	N	76°41′.37	76°39′.65			76° 40′.84	64	43°.1	30.221	
				S	76°37′.91								
Oct.18,	11*h*.02*m*., A.M.	0°&180°	2	N	76°43′.91	76°42′.03					52°	30.096	Cloudy, strong wind from S.
				S	76°40′.15								

Dip observed in the plane of the magnetic meridian, by a mean of the results of the two needles, (number of observations, ninety-six,) . . . . . 76° 40′.419

		θ				δ′	δ″		δ				
Oct.16,	8*h*.05*m*., A.M.	10°&190°	1	S	76°52′.84	76° 52′.1	76°52′.14	+0′.04	76° 40′.36	32	30°.5	30.350	Weather clear; fresh S. W. wind during the observations this day.
				N	76°51′.36								
" "	9*h*.03*m*., A.M.	20°&200°	1	N	77°26′.47	77° 28′.62	77°27′.07	—1′.55	76° 42′.06	32	33°.2	30.350	
				S	77°30′.78								
" "	10*h*.01*m*., A.M.	30°&210°	1	S	78°26′.09	78° 25′.06	78°24′.23	—0′.83	76° 41′.18	32	35°.2	30.350	
				N	78°24′.03								
" "	10*h*.55*m*., A.M.	40°&220°	1	N	79°41′.40	79° 42′.95	79°42′.91	—0′.04	76° 40′.46	32	37°	30.350	
				S	79°44′.50								
" "	11*h*.46*m*., A.M.	50°&230°	1	S	81°22′.50	81° 20′.59	81°20′.55	—0′.04	76° 40′.46	32	38°.5	30.350	
				N	81°18′.68								
" "	1*h*.04*m*., P.M.	60°&240°	1	N	83°13′.56	83° 14′.60	83°14′.73	+0′.13	76° 40′.17	32	41°.25	30.350	
				S	83°15′.65								
" "	2*h*.30*m*., P.M.	70°&250°	1	S	85°24′.97	85° 23′.78	85°22′.09	—1′.69	76° 45′.13	32	43°	30.350	
				N	85°22′.59								
" "	3*h*.32*m*., P.M.	80°&260°	1	N	87°40′.59	87° 40′.4	87°38′.67	—1′.73	76° 49′.85	32	44°.5	30.347	
				S	87°40′.22								
" 18,	3*h*.53*m*., P.M.	90°&270°	1	S	89°59′.25	89° 59′.48	90°00′	+0′.52		32	55°.7	30.340	
				N	89°59′.70								

Dip, by two hundred and fifty-six observations on needle No. 1, observed in the various azimuths stated in column three, and reduced by computation to the plane of the magnetic meridian, ... 76° 42′.45

Oct.17,	10*h*.13*m*., A.M.	10°&190°	2	S	76°51′.40	76° 52′.91	76°52′.14	—0′.77	76° 39′.97	32	47°	30.170	Clear; fresh S. W. wind on the 17th.
" 18,	11 37 "			N	76°54′.43						52°.5	30.090	
" 17,	10*h*.32*m*., A.M.	20°&200°	2	S	77°24′.37	77° 27′.18	77°27′.07	—0′.11	76° 40′.54	32	47°.5	30.170	
" 18,	11 53 "			N	77°30′.00						53°.5	30.090	Cloudy; strong south wind on the 18th.
" 17,	10*h*.59*m*., A.M.	30°&210°	2	S	78°21′.22	78° 22′.90	78°24′.23	+1′.33	76° 38′.18	32	49°	30.170	
" 18,	0 12 P.M.			N	78°24′.59						54°	30.090	
" 17,	11*h*.40*m*., A.M.	40°&220°	2	S	79°38′.56	79° 40′.63	79°42′.91	+2′.28	76° 37′.51	32	50°	30.170	Do.
" 18,	0 31 P.M.			N	79°42′.70						54°	30.090	
" 17,	0*h*.11*m*., P.M.	50°&230°	2	S	81°19′.59	81° 20′.53	81°20′.55	+0′.02	76° 40′.48	32	50°	30.172	Do.
" 18,	0 55 "			N	81°21′.47						55°	30.084	
" 17,	0*h*.35*m*., P.M.	60°&240°	2	S	83°14′.62	83° 14′.21	83°14′.73	+0′.52	76° 39′.42	32	50°	30.172	Do.
" 18,	1 14 "			N	83°13′.81						54°.75	30.084	
" 17,	0*h*.53*m*., P.M.	70°&250°	2	S	85°23′.09	85° 23′.21	85°22′.09	—1′.12	76° 43′.35	32	51°.5	30.172	Do.
" 18,	1 30 "			N	85°23′.34						55°.5	30.084	
" 17,	1*h*.12*m*., P.M.	80°&260°	2	S	87°37′.81	87° 38′.01	87°38′.67	+0′.66	76° 36′.74	32	51°.5	30.172	Do.
" 18,	1 45 "			N	87°38′.22						56°	30.078	
" 18,	2*h*.12*m*., P.M.	90°&270°	2	N	90°00′.22	90° 00′.59	90°00′	—0′.59		32	56°.5	30.070	Cloudy; strong south wind.
	2 57 "			S	90°00′.96						56°		

Dip, by two hundred and fifty-six observations on needle No. 2, observed in the various azimuths stated in column three, and reduced, by computation to the plane of the magnetic meridian, ... 76° 39′.52

From the foregoing table we have the following exhibit of the magnetic dip at Rouse's Point:

	Needle No. 1.	Needle No. 2.	Mean of both Needles.
By thirty-two observations made in the plane of the magnetic meridian, ...	76° 40′		76° 40′.42
By sixty-four observations made in the plane of the magnetic meridian, ...		76° 40′.84	
By two hundred and fifty-six observations made at every 10° of azimuth, from 0° to 80° inclusive, and reduced to the plane of the magnetic meridian, ...	76° 42′.45	76° 39′.52	76° 40′.98

Showing scarcely a sensible difference between the dip observed by both needles in the plane of the magnetic meridian and that deduced from the observations on both needles, in various azimuths, from 10° to 80°, inclusive.

The results shown in column ten of table A, seem exceedingly satisfactory for both needles, especially when it is considered that an error of 1′, in reading the inclination at the azimuth of 70°, would cause an error in the computed dip of 2′.6, and a like error at the azimuth of 80° would cause an error in the computed dip of 5′.5.

A very slight defect in the instrument, indeed, either in the form of the axle of the needle observed on, or the want of perfect freedom from magnetism in the metal of which the dip-circle is composed, would operate as sufficient cause to produce a much greater error than 1′ in the observed inclination at those high azimuths, even supposing no errors to be made in the actual reading of the needles.

But we consider the quantities in column nine as the more correct indices of the perfection of the form of the axles of the needles, and of the freedom of the dip-circle from magnetism and from ferruginous matter.

In regard to needle No. 1, the quantities in that column show that the greatest difference between the observed inclination in any azimuth, and the inclination computed from the data afforded by the observed azimuthal angle, and the observed dip in the plane of the magnetic meridian, is only 1′.73.

In regard to needle No. 2, the greatest difference is 2′.28, but the next greatest is only 1′.33.

The character of this instrument and the form of the axles of its needles have been still farther tested, and in a manner equally satisfactory, by the following highly interesting series of observations, made at the astronomical station on the east shore of Lake Memphremagog, in Stanstead, Canada East, by Lieutenant A. W. Whipple, between the 1st and 7th of November, 1845.

These observations and the several results are exhibited in the table marked B, as rendered by Lieutenant Whipple. The mode of observation adopted by him was, first, to ascertain the dip by both needles from careful observations made with the dip-circle, in the plane of the magnetic meridian; he then observed at every 15° of azimuth from 0° to 90°, turning the plane of the dip-circle round from north towards the west, and then in the several planes, at right angles to the former ones.

By combining the inclinations observed in pairs of planes at right angles to one another, the equivalent dip for the plane of the magnetic meridian was deduced by the formula

$$\text{Cotan.}^2\,\delta = \text{Cotan.}^2\,i + \text{Cotan.}^2\,i'$$

In which i represents the inclination observed in any azimuthal plane, i' that observed in another azimuthal plane perpendicular to the former, and δ the equivalent dip reduced to the plane of the magnetic meridian.

Here, too, are shown, in column eight, the values of δ'', deduced by the formula previously quoted, in order to compare them directly with δ', here represented by i and i' in column seven, and the difference, + or −, between δ' and δ'' are shown in column nine as the true indices of the perfection of the instrument in respect to the form of the axles of the needles and the freedom of the dip-circle from magnetism and matter having any attractive or repulsive effect upon the needles.

B

LIV. *Observations of the dip of the magnetic needle, made in the plane of the magnetic meridian, and also in various azimuths, at every 15° from 0° to 90°, and from 270° to 360°; with Major Graham's dip instrument, by Gambey of Paris.*

At the astronomical station on Lake Memphremagog, in Stanstead, Canada East. Latitude 45° 00′ 29″.2, N.; Longitude 4*h*. 48*m*. 50*s*. W.

Observer.—Lieutenant A. W. Whipple, United States Corps of Topographical Engineers.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date.	Approximate mean solar time of observation.	Magnetic azimuth of plane of dip-circle, reading of verniers.	No. of Needle.	Polarity of Marked end of Needle.	Dip observed in azimuth by each needle.	Dip in azimuth by observation.	Computed dip in azimuth.	Excess of computed over observed dip in various azimuths.	Dip reduced to plane of the magnetic meridian.	No. of observations.	Thermometer. (Fah.)	Barometer.	Remarks.
1845.												IN.	
Nov. 1,	2*h*.13*m*., P.M.	00° & 180°	1	N	76°07′.41	76° 07′.83			76°07′.83	32	63°	28.849	The whole day was cloudy and damp; there having been a violent storm of wind and rain the preceding night.
	3 00 "			S	76°08′.25						59°	28.839	
Nov. 1,	3*h*.23*m*., P.M.	0° & 180°	2	S	76°05′.81	76° 08′.96			76°08′.96	32	59°	28.840	
	4 04 "			N	76°12′.12						57°.5	28.840	Morning very foggy; the day cloudy; much rain last night; atmosphere moist; wind south-east.
Nov. 4,	11*h*.00*m*., A.M.	0° & 180°	1	S	76°10′.25	76° 09′.14			76°09′.14	32	62°.5	28.884	
	4 37 P.M.			N	76°08′.03						63°.5	28.884	
Nov. 6,	11*h*.29*m*., A.M.	0° & 180°	2	N	76°11′.25	76° 08′.58			76°08′.58	32	44°	28.866	Wind S.W. and a fresh breeze; cloudy in the morning; fair in the afternoon.
	5 00 P.M.			S	76°05′.91						43°	28.873	
Nov. 7,	9*h*.59*m*., A.M.	0° & 180°	2	S	76°06′.19	76° 08′.89			76°08′.89	32	43°	28.990	
	1 33 P.M.			N	76°11′.59						46°.5	28.975	Cloudy and rainy; fresh west wind.

Dip observed on the plane of the magnetic meridian, by a mean of one hundred and sixty observations on two needles, . . 76° 08′.64

		θ				δ′ observed.	δ″ computed		δ				
Nov. 4,	11*h*.25*m*., A.M.	195° & 15°	1	S	76°37′.81	76°36′.68 = *i*	76° 35′.84	−0′.84		32	65°	28.884	See above remark for the 4th Nov.
	5 00 P.M.			N	76°35′.56						63°	28.889	
Nov. 4,	11*h*.51*m*., A.M.	285° & 105°	1	S	86°24′.22	86°22′.30 = *i*′	86° 20′.80	−1′.50	76°09′.72	32	66°	28.884	On the 5th the weather was cloudy and rainy. A light south wind.
" 5,	10 35 "			N	86°20′.38						54°	28.730	
Nov. 4,	0*h*.16*m*., P.M.	210° & 30°	1	S	77°58′.34	77°57′.42 = *i*	77° 56′.44	−0′.98		32	67°.5	28.884	
" 5,	10 50 A.M.			N	77°56′.50						54°	28.728	
Nov. 4,	0*h*.38*m*., P.M.	300° & 120°	1	S	82°58′.88	82°59′.35 = *i*′	82° 58′.10	−1′.25	76°09′.97	32	70°	28.884	
" 5,	11 37 A.M.			N	82°59′.81						54°	28.727	
Nov. 4,	0*h*.56*m*., P.M.	225° & 45°	1	S	80°07′.75	80°05′.98 = *i*	80° 06′.18	+0′.20		32	70°	28.884	
" 5,	11 55 A.M.			N	80°04′.22						54°	28.725	
Nov. 4,	1*h*.17*m*., P.M.	315° & 135°	1	S	80°07′.03	80°06′.95 = *i*′	80° 06′.18	−0′.77	76°08′.77	32	68°.5	28.884	
" 5,	0 16 "			N	80°06′.87						55°.5	28.719	
Nov. 4,	1*h*.42*m*., P.M.	240° & 60°	1	S	82°58′.56	82°58′.42 = *i*	82° 58′.10	−0′.32		32	68°.2	28.884	
" 5,	0 34 "			N	82°58′.28						56°.5	28.716	
Nov. 4,	2*h*.01*m*., P.M.	330° & 150°	1	S	77°57′.91	77°55′.85 = *i*′	77° 56′.44	+0′.59	76°08′.20	32	68°.7	28.884	
" 5,	0 56 "			N	77°53′.78						55°.2	28.712	
Nov. 4,	2*h*.26*m*., P.M.	255° & 75°	1	S	86°23′.91	86°23′.89 = *i*	86° 20′.80	−3′.09		32	69°	28.884	
" 5,	1 18 "			N	86°23′.88				76°10′.12		53°.5	28.710	
Nov. 4,	2*h*.45*m*., P.M.	345° & 165°	1	S	76°37′.84	76°36′.36 = *i*′	76° 35′.84	−0′.52		32	70°	28.884	
" 5,	1 38 "			N	76°34′.88						53°.2	28.708	
Nov. 4,	3*h*.14*m*., P.M.	270° & 90°	1	S	89°59′.09	90°00′.17 = *i*	90° 00′.00	−0′.17		32	68°.5	28.884	
" 5,	1 56 "			N	90°01′.25						53°.5	28.706	

Dip, by three hundred and twenty observations on needle No. 1, observed in the various azimuths stated in column three, and reduced by computation to the plane of the magnetic meridian, ... 76° 09′.356

Nov. 7,	9*h*.19*m*., A.M.	90° & 270°	2	S	89°59′.25	89°59′.41	90° 00′.00	+0′.59		32	40°.5	28.996	See above remark on the weather of the 7th.
	1 19 P.M.			N	89°59′.56						47°.2	28.978	
" "	10*h*.17*m*., A.M.	15° & 195°	2	S	76°32′.88	76°34′.92 = *i*	76° 35′.84	+0′.92		32	44°	28.990	
	1 48 P.M.			N	76°36′.97				76°07′.51		45°.2	28.978	
" "	10*h*.31*m*., A.M.	105° & 285°	2	S	86°20′.53	86°20′.20 = *i*′	86° 20′.80	+0′.40		32	44°.2	28.989	
	2 01 P.M.			N	86°19′.88						44°	28.975	
" "	10*h*.48*m*., A.M.	30° & 210°	2	S	77°53′.44	77°56′.00 = *i*	77° 56′.44	+0′.44		32	44°.2	28.988	
	2 15 P.M.			N	77°58′.56				76°08′.14		43°	28.979	
" "	11*h*.03*m*., A.M.	120° & 300°	2	S	82°58′.44	82°58′.18 = *i*′	82° 58′.10	−0′.08		32	45°.2	28.986	
	2 27 P.M.			N	82°57′.91						42°.2	28.971	
" "	11*h*.19*m*., A.M.	45° & 225°	2	S	80°03′.25	80°05′.04 = *i*	80° 06′.18	+1′.14		32	46°.8	28.986	
	2 40 P.M.			N	80°06′.84						41°.8	28.969	
" "	11*h*.32*m*., A.M.	135° & 315°	2	S	80°01′.81	80°04′.11 = *i*′	80° 06′.18	+2′.07	76°06′.17	32	47°.2	28.985	
	2 53 P.M.			N	80°06′.41						41°.5	28.968	
" "	11*h*.46*m*., A.M.	60° & 240°	2	S	83°03′.72	82°60′.26 = *i*	82° 58′.10	−2′.16		32	47°.7	28.984	
	3 05 P.M.			N	82°56′.81						41°.2	28.968	
" "	0*h*.04*m*., P.M.	150° & 330°	2	S	77°51′.72	77°54′.50 = *i*′	77° 56′.44	+1′.94	76°07′.85	32	47°.7	28.982	
	3 16 "			N	77°57′.28						40°.7	28.969	
" "	0*h*.19*m*., P.M.	75° & 225°	2	S	86°22′.09	86°21′.59 = *i*	86° 20′.80	−1′.09		32	46°.8	28.981	
	3 32 "			N	86°21′.59						40°.2	28.970	
" "	0*h*.36*m*., P.M.	165° & 345°	2	S	76°33′.28	76°34′.97 = *i*′	76° 35′.84	+0′.87	76°07′.93	32	46°.	28.980	
	3 44 "			N	76°36′.66						40°.	28.971	

Dip, by three hundred and twenty observations on needle No. 2, observed in the various azimuths stated in column three, and reduced by computation to the plane of the magnetic meridian, ... 76° 07′.53

Table B affords the following exhibit of the dip by the observations made at the Stanstead station, in Canada East:

	Needle No. 1.	Needle No. 2.	Mean of both needles.
By sixty-four observations made in the plane of the magnetic meridian,	76° 08′.48		76° 08′.64
By ninety-six observations made in the plane of the magnetic meridian,		76° 08′.80	
By three hundred and twenty observations made at every 15° of azimuth, between 0° and 90°, and between 270° and 360° of the azimuth circle, and reduced to the plane of the magnetic meridian,	76° 09′.35	76° 07′.53	76° 08.′44

Here we have a closer coincidence even, than before, between the dip observed by the two needles in the plane of the magnetic meridian, and that deduced from the azimuthal observations.

What is also particularly satisfactory in this series is, that the greatest difference between any one of the reduced dips found in column ten and the dip derived from one hundred and sixty observations on the two needles, in the plane of the magnetic meridian, is, for needle No. 1, only 1′.48, and for needle No. 2, only 1′.47.

The greatest difference, in column nine, between the inclination observed in any azimuth at this station, and that computed for the same azimuth, is, for needle No. 1, only 3′.09, and this is for an azimuth so great as 75° from the magnetic meridian. The next greatest difference for this needle is only 1′.5.

The greatest difference, in that column, for needle No. 2, is only 2′.16, being for azimuth 60°, the next greatest is 2′.07, and the third in order is 1′.94.

The tests afforded by the two series of observations presented in tables A and B, of the qualities of the instruments, both as to the accuracy of form of the axles of the two needles, and the freedom of the metal of which the instrument is composed from magnetism and from all matter of a nature to attract or repel the needles from the true angles of inclination, seem exceedingly satisfactory, and must be considered as entitling the extensive series of observations that have been made with it to every confidence. It will be remembered, too, that these tests have been thus rigidly applied after the instrument has been in use nearly five years, and they show that it has not been deteriorated in its qualities by the many and very extensive journeys that have been performed with it amidst many very trying difficulties, resulting from the peculiarities of the country it has traversed.

We must not omit to acknowledge the credit due to that distinguished artist, Mr. Gambey of Paris, for the production of so perfect an instrument for measuring the magnetic dip.

LV. *Canaan Corner, Vermont and Canada Boundary.*

Latitude 45° 00′ 49″, N.; Longitude 4*h*. 46*m*. 04*s*., west. Observations for the dip made in the plane of the magnetic meridian, by Major Graham.

NOTE.—The point of observation is one hundred and thirty feet north-west from the iron monument on Hall's Stream, which marks the eastern extremity of the line of Valentine and Collins, running thence along the northern limit of the states of Vermont and New York, (under the provisions of the treaty of Washington, of 1842,) to the river St. Lawrence, at St. Regis.

December 19, 1845.

Mean time of observation.	Temperature (Fah.)	Polarity of marked end of needle.	Dip observed with poles direct and reversed.	No. of readings.	Dip by each needle.	Total No. of readings.
			NEEDLE No. 1.			
1*h.* 31*m.*, P. M.	42°	N	76° 24′.31	24	76° 22′.95	48
2 03 P. M.	39°	S	76° 21′.6	24		
			NEEDLE No. 2.			
2*h.* 30*m.*, P. M.	38°	N	76° 25′.12	24	76° 24′.01	48
3 00 P. M.	37°	S	76° 22′.91	24		

Dip, by a mean of ninety-six observations on the two needles, ... 76° 23′.48

The weather was cloudy, with an occasional slight fall of snow and a very gentle wind from the south-west during the observations. The snow two feet deep upon the ground. The observations were made under a tent free from iron fixtures.

These are the last observations made in the field during this season

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ERRATA IN THE PRECEDING PAPER.

Page 333, transpose the date, February 12th, to head the observations with marked end of needle A, north pole.

" 334, and following pages, italicise the words, "First," "Second," &c.

" 339, in tables two and three insert the initials *J. D. G.* in the last column, as observer.

" 341, sixth line from top, for "The calculations were therefore received," read *The calculations were therefore reviewed.*

" 345, omit the words "AND DECLINATION," in the running head, from this page to the end of the paper.

" 351, place the remarks commencing, "Having applied the magnets," in relation to reversing the poles of the needle, in a column on the right side of the table, opposite to the repetition of needle No. 1 with marked end north.

" 354, last line, for "71° 55′.85," read 71° 50′.7.

" 363, first line, for "late the Widow Michean's," read, *late the Widow Micheau's.*

" 371, thirteenth line from top, for "77°51′.07," read, 76°51′.07.

" 375, table A, fifth line from top, for "4*h.* 53*m.* 25*s.*," read, 4*h.* 53*m.* 27*s.*

" 378, third line from top, longitude of the astronomical station at Lake Memphremagog, for 4*h.* 48*m.* 50*s.*, W. read, 4*h.* 48*m.* 52*s.*, W.

" 378, table B, end of first part of the table, for "Dip observed on," read, *Dip observed in.*

☞It must be remarked that the repetition of the name of the same station, which so often occurs, was intended to have been a running heading, at the top of the pages. See pages 333 and 346.

ADDITIONAL ERRATA AND CORRECTIONS TO BE MADE IN THE PRECEDING PAPER.

Page 332, lines 9, 10, and 11 from top, and fifth column from the left, erase the inverted commas placed under the time 11*h*. 00*m*., A.M., as the times of the observations immediately following were not the same.

" " in table third, insert the initials J. D. G. in the right hand column, as observer.

" 333, in tables 1, 2, and 3, insert the initials J. D. G., in the right hand column, as observer.

" " The date, (February 12th,) stands printed in its proper place. Therefore erase the remark in the preceding "errata" which refers to this date.

" 339, thirteenth line from top, in column 5th, for 6*h*. 30*m*., P.M., read 6*h*. 30*m*., A.M.

" 342, The time of observation, 3*h*., P.M., should have been placed opposite the middle of the space between the fourth and fifth lines from the top, so as to indicate that as the middle time of observation on Needle No. 1.

" " In tables two and three, insert the initials J. D. G. in the right hand column, as observer.

" 348, fourteenth line from top, insert 92°; and nineteenth line from top, insert 97°, for the attached thermometer in the ninth column from the left.

" 351, third line from top, for 70° 10′.73 read 71° 10′.73.

" 375, third line from top, omit the comma before the words "by Gambey, of Paris."

" 378, fifth line from bottom, for 75° and 225°, read 75° and 255°, in the third column from the left.

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Observations made at the Magnetical and Meteorological Observatory, at Toronto, in Canada. Printed by order of Her Majesty's Government, under the superintendence of Lieut. Colonel Edward Sabine, of the Royal Artillery. Vol. I. 1840, 1841, 1842. London, 1845. 4to.—*Through Hon. Edward Everett.*

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Annuaire Magnétique et Météorologique du Corps des Ingénieurs des Mines du Russie, ou Recueil d'Observations, &c., publiées par ordre de S. M. l'Empereur Nicolas I. sous les auspices de M. le Comte Cancrine, Chef du Corps, &c., par A. T. Kupffer: Année 1840–1841. St. Petersburg, 1842–1843. 4to.

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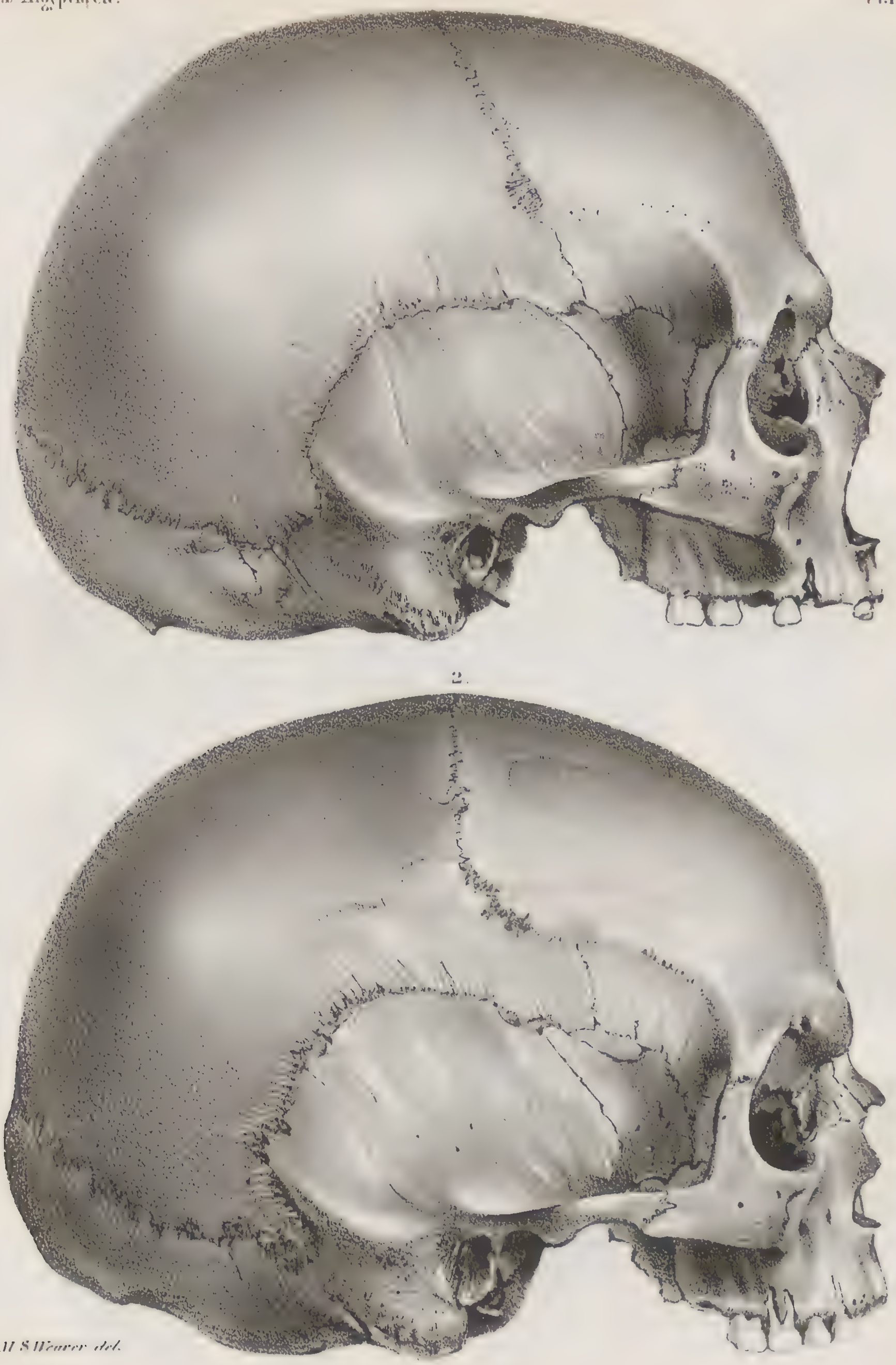

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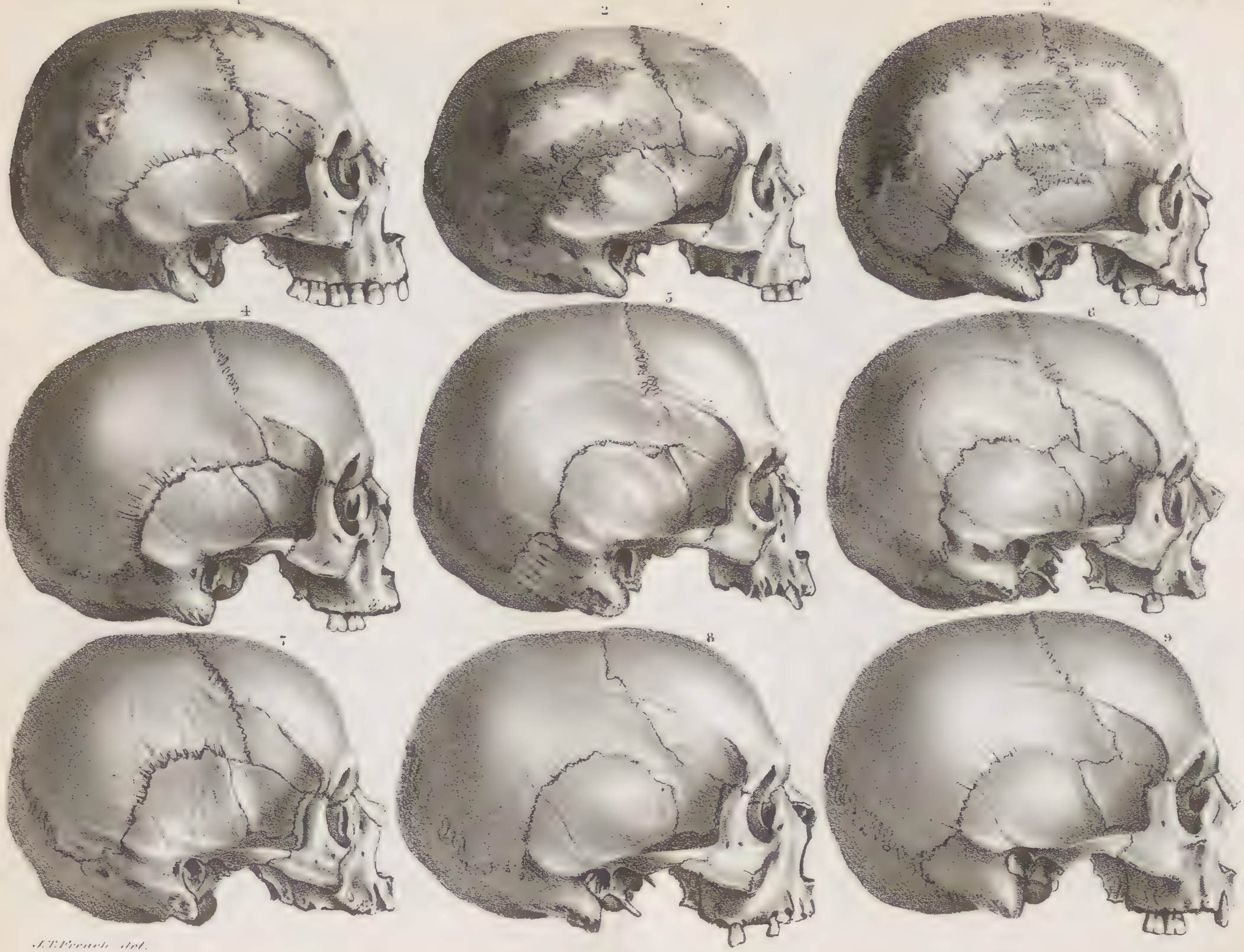

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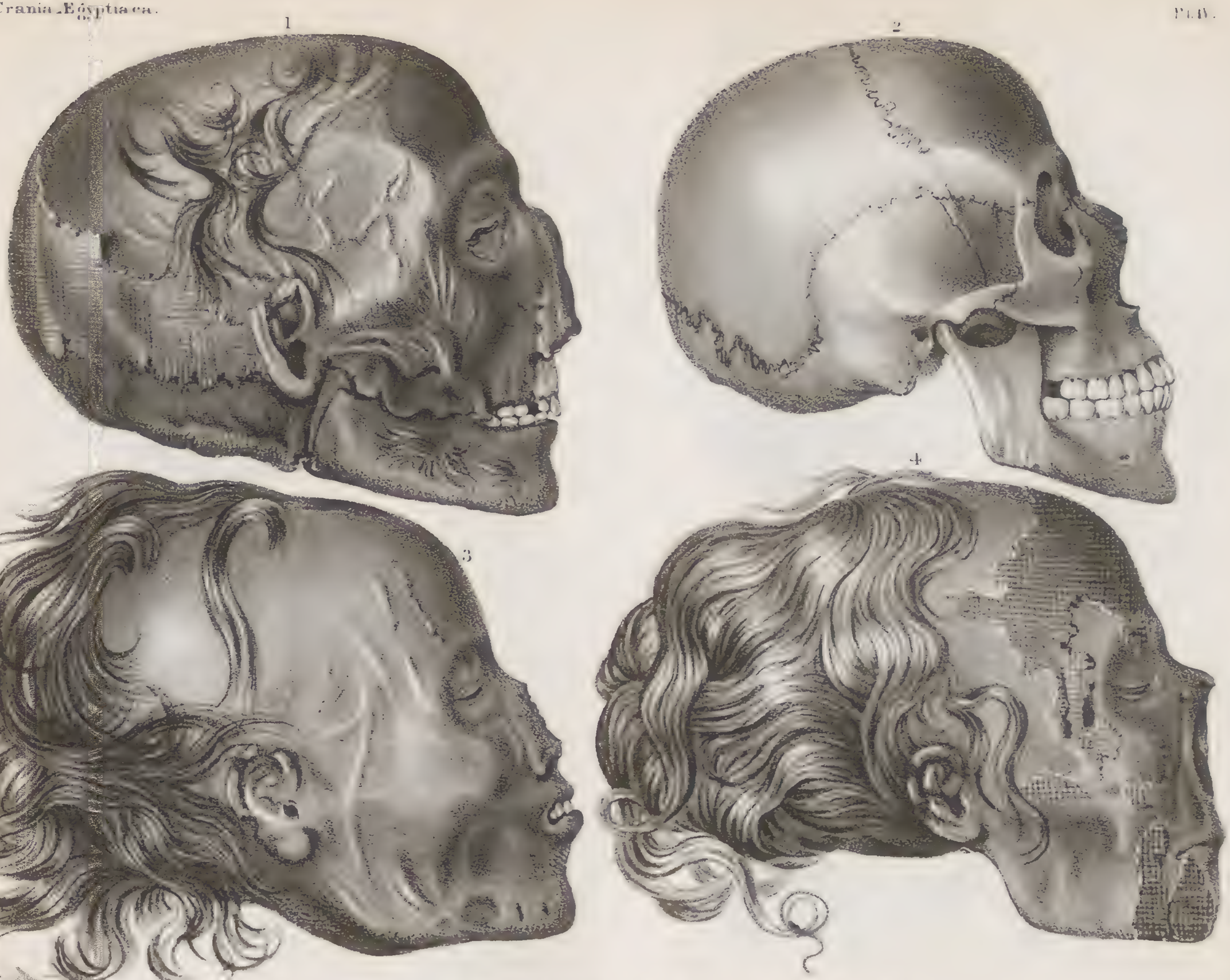

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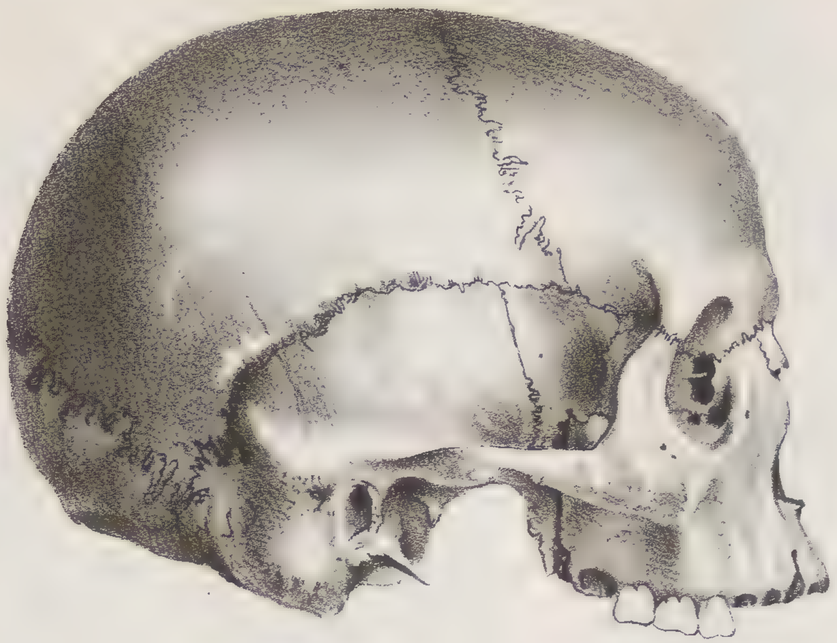

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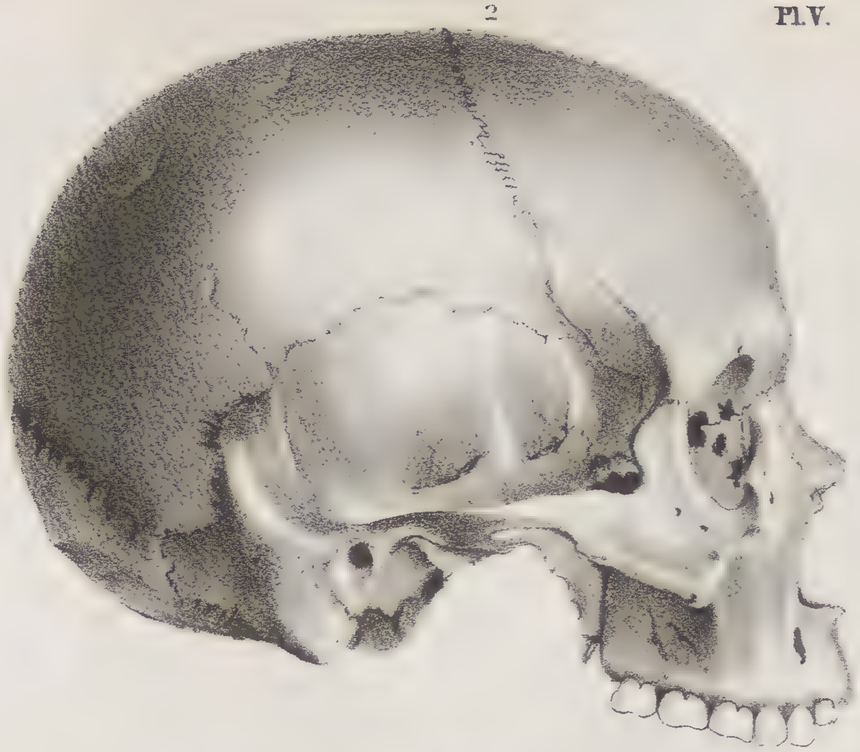

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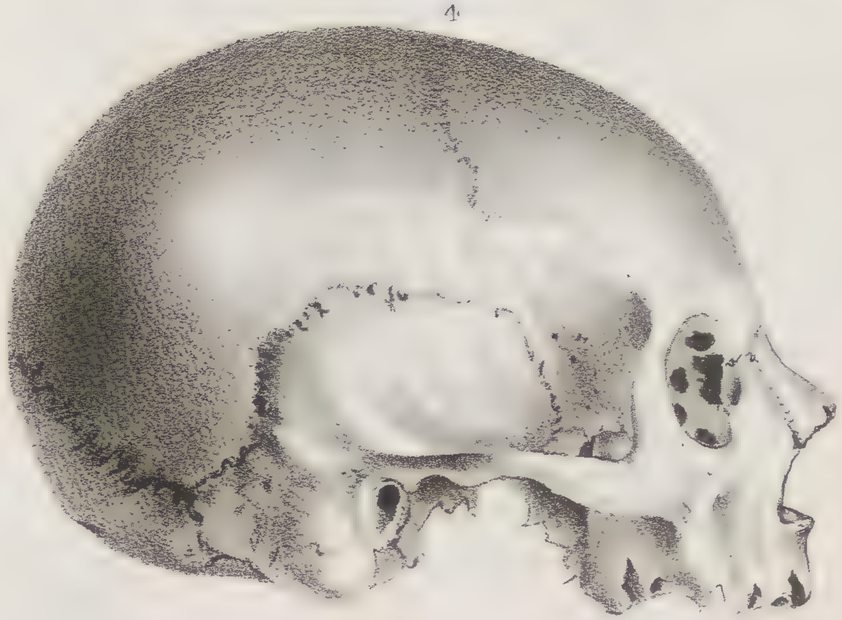

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FROM THE CATACOMBS OF THEBES.

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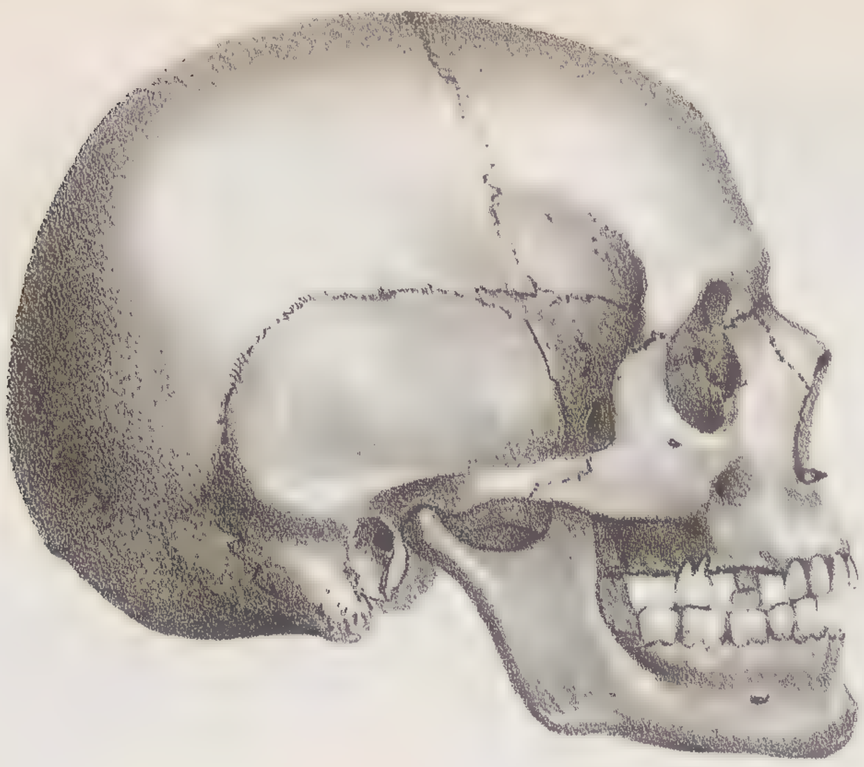
Pl. VII

1



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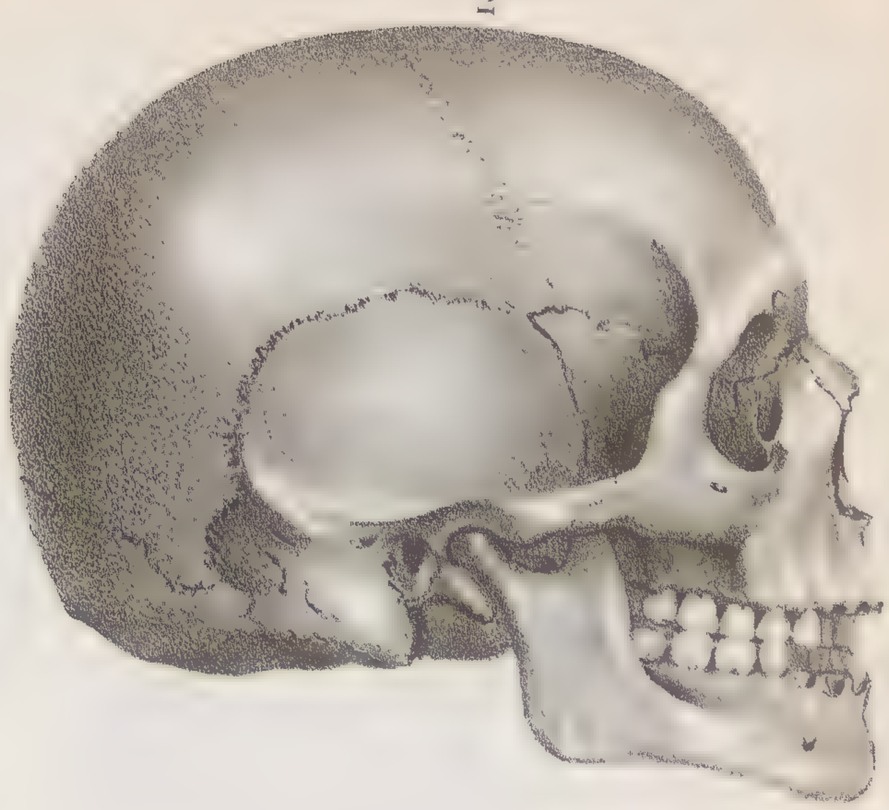

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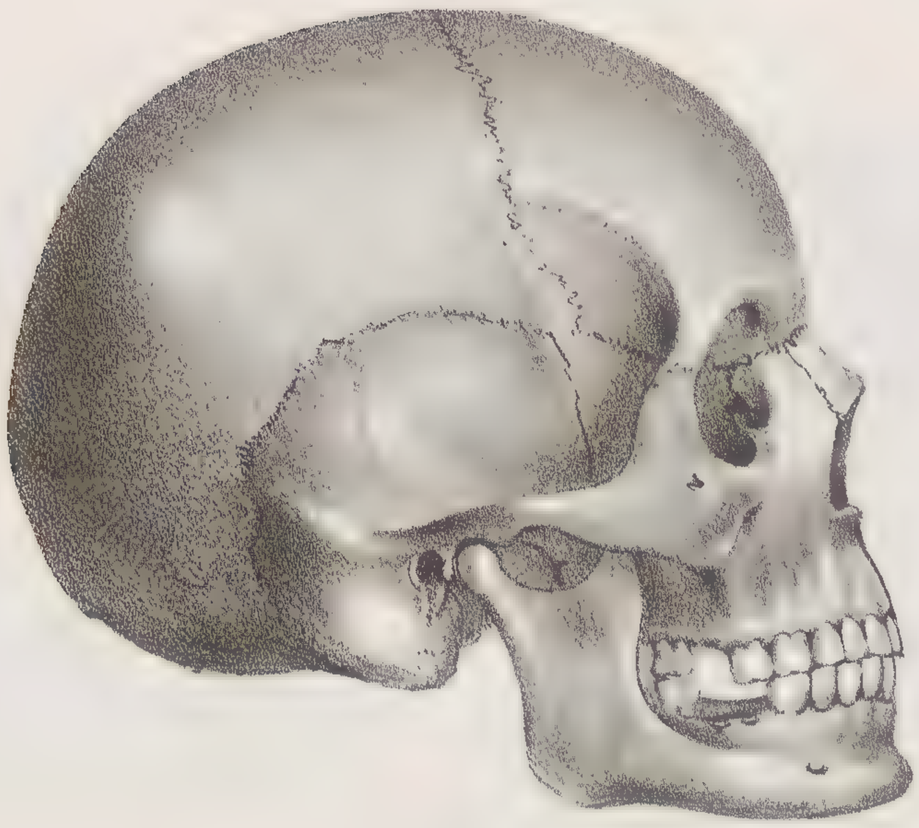

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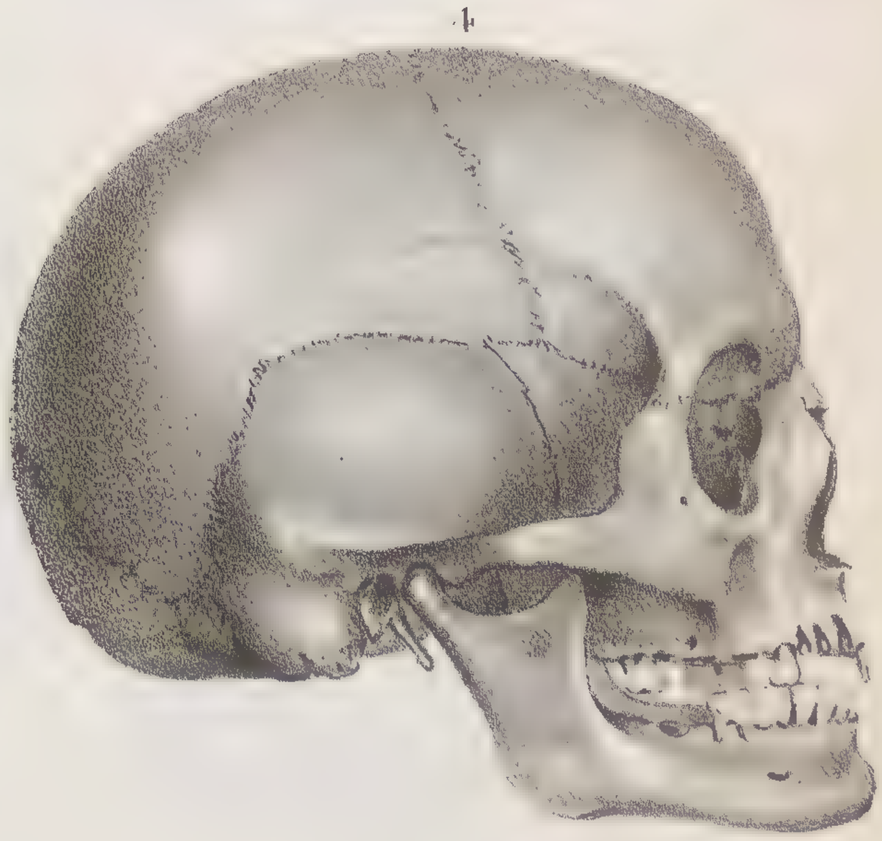

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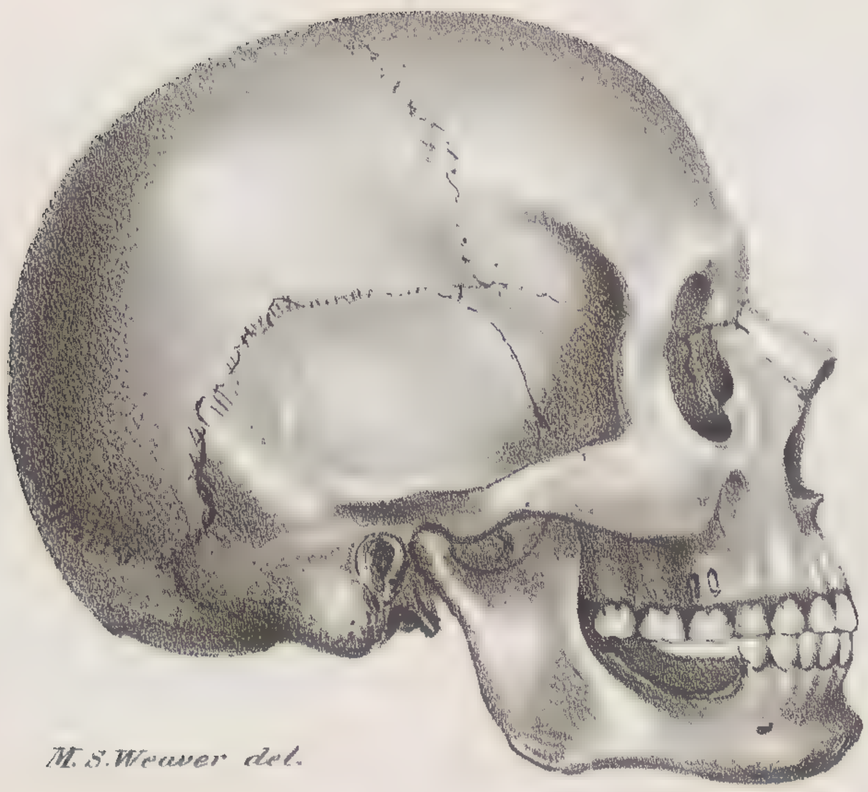

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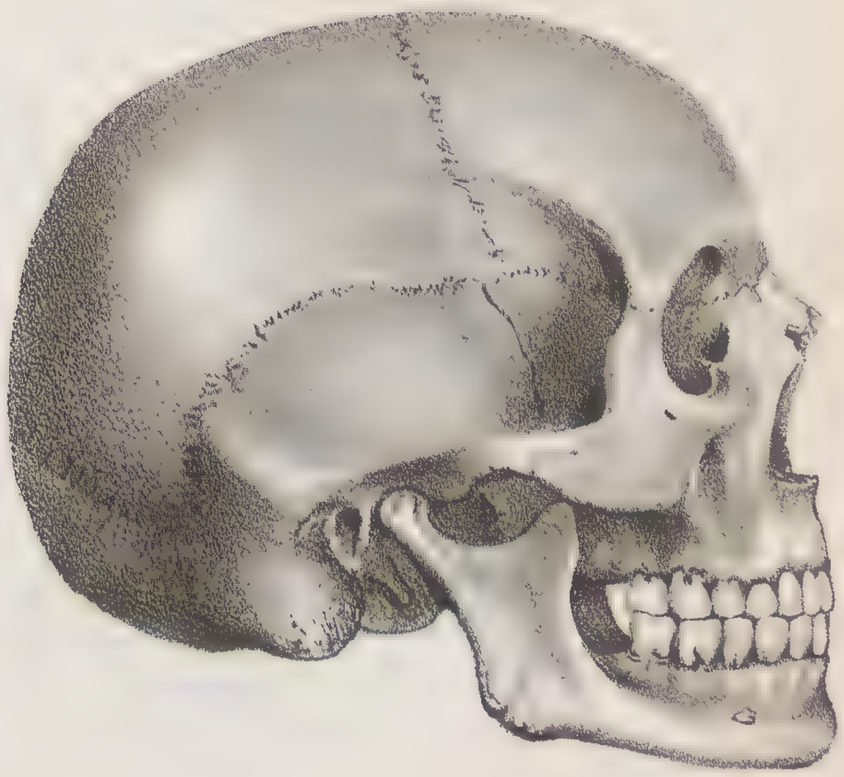

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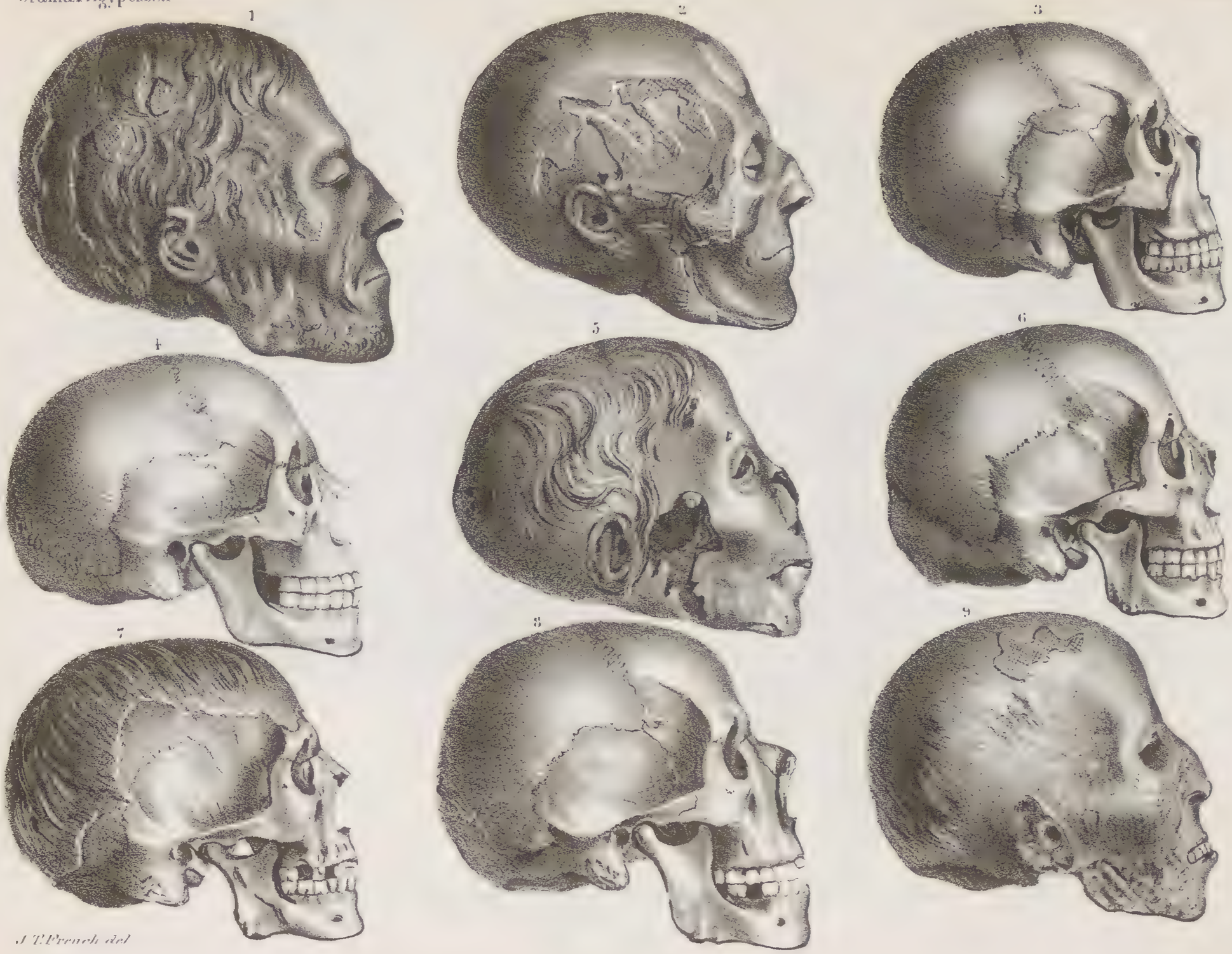
Pl. VIII.



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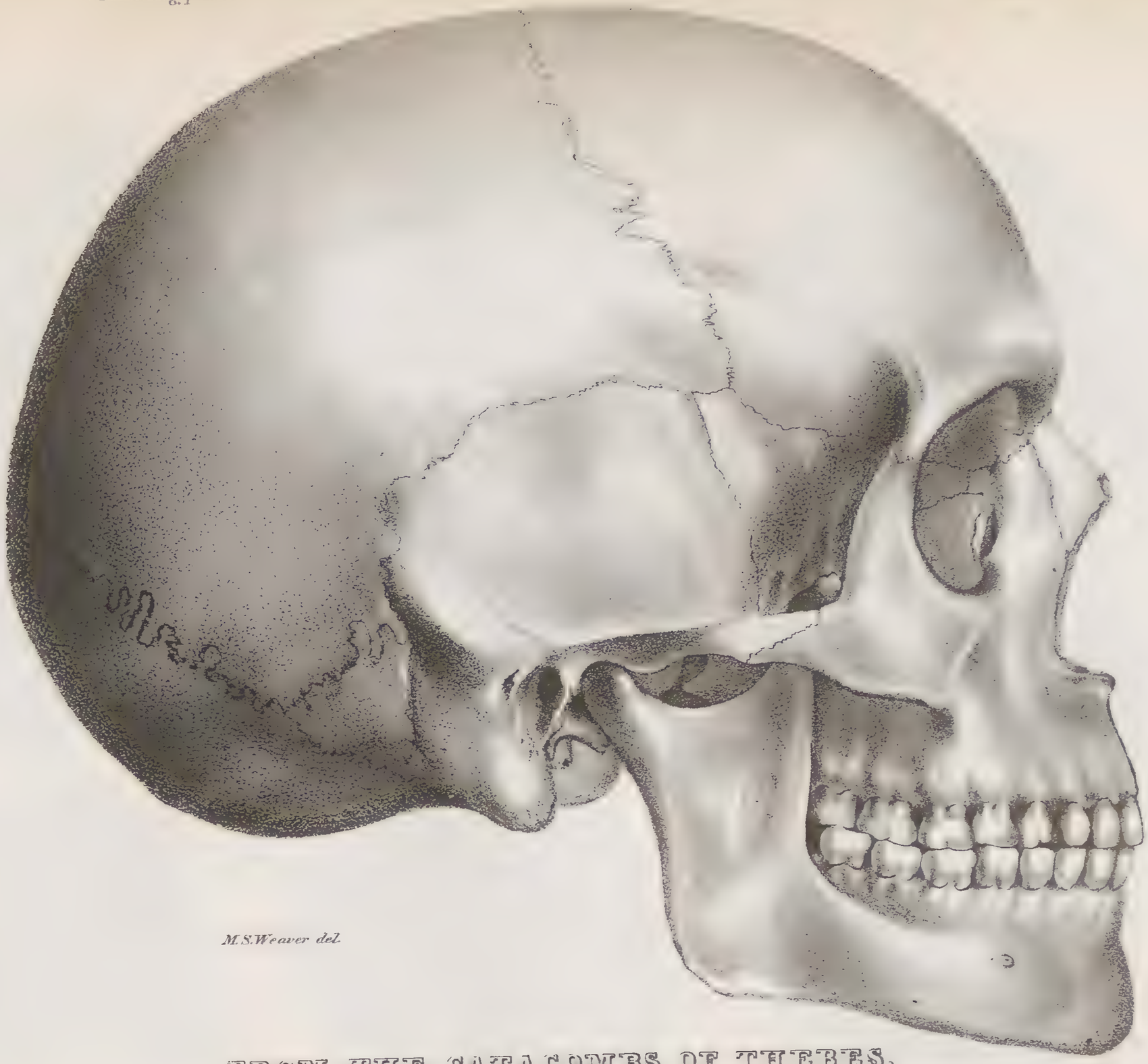

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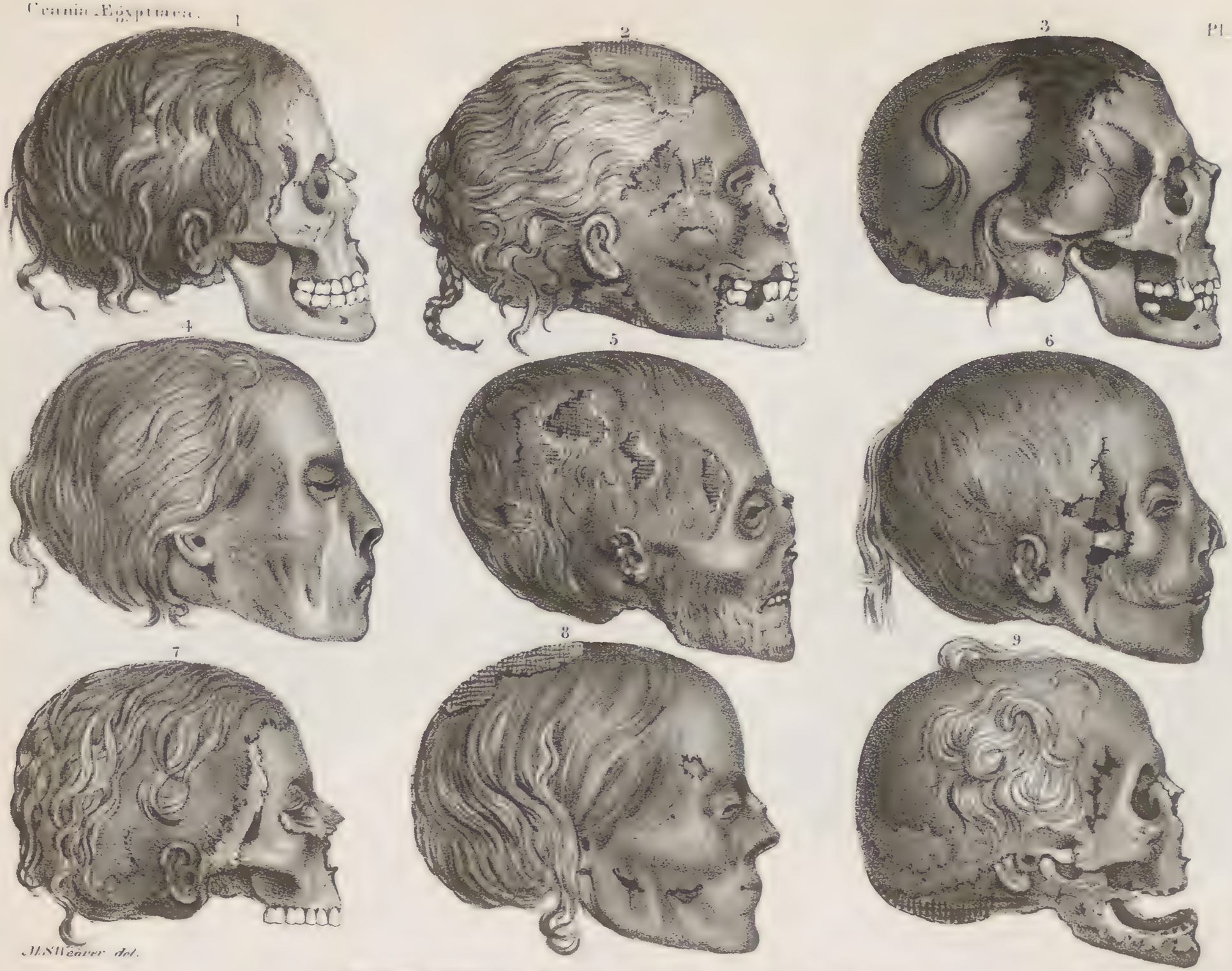

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Pl. XII.

Figs. 1. 2. Catacombs of Thebes.
Figs. 3.-4.-5. Tombs of Koum-Ombos.
Figs. 6. 7. From a Tumulus at Philoe.
Figs. 8. 9. From Deboud. in Nubia.

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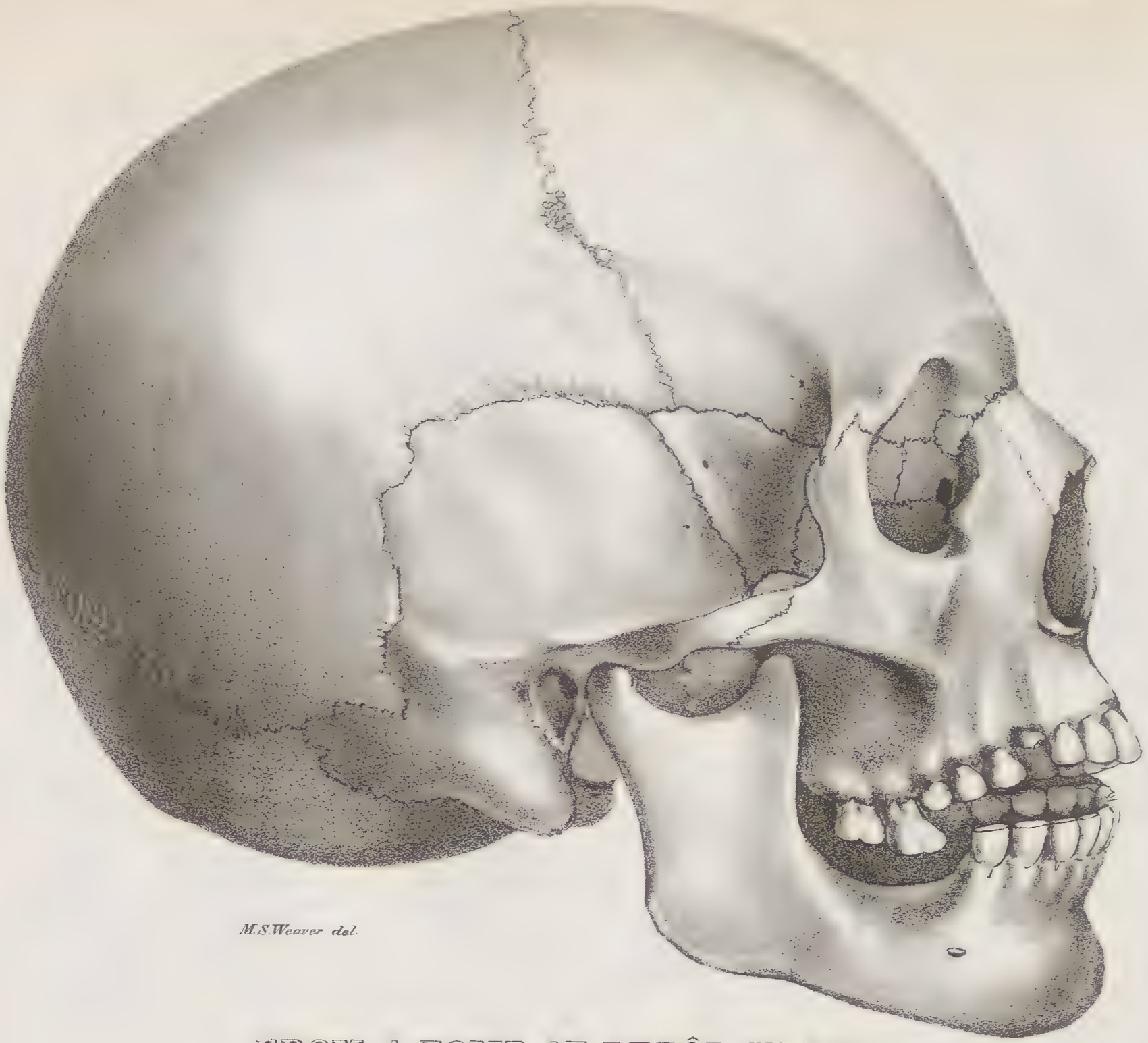

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Fig. 1. Amenoph I.

2 Horus.

3 Menepthah I. *as Priest.*

4 Ramses III.

5 Nofre Ari.

6 Ramses IV.

7 Ramses IX.

8 Ramses X.

9 Ramses XI.

10 Amenmeses.

11 Nitocris.

12 Daughter of Pihaa'.

13 Aames Nofre Ari.

14 Thotmes V.

15 Metumva.

16 Sabbacon.

17 Sabatok.

18 Tirhaka.

19 Hamyarite Arab.

20 Hamyarite Arab.

21 Indo-Semitic?

22 Meroite.?

23 Pelasgic.

24 Semitic.

Drawn from Rossellini by R.H.Kern.

On stone by M.S.Weaver

Figs. 1. to 18. (inclusive) *Portraits of the Kings and Queens of Egypt.*
" 19. to 24. " People of various Nations.

Lith. of T. Sinclair Phil.ª

CHART 1.

Morning of Feb. 15 1842.

——————— *Lines of equal pressure*

..... *Lines of equal therm. oscillation.*

○ *calm*

Clear Sky. *Rain*

Clouds *Snow.*

*Lith of Sinclair Philad*ª

PLATE

CHART 2.

Evening of Feb. 15 1842.

——— *Lines of equal pressure*

..... *Lines of equal therm. oscillat.*

○ *calm*

Clear Sky.

Clouds.

Rain

Snow.

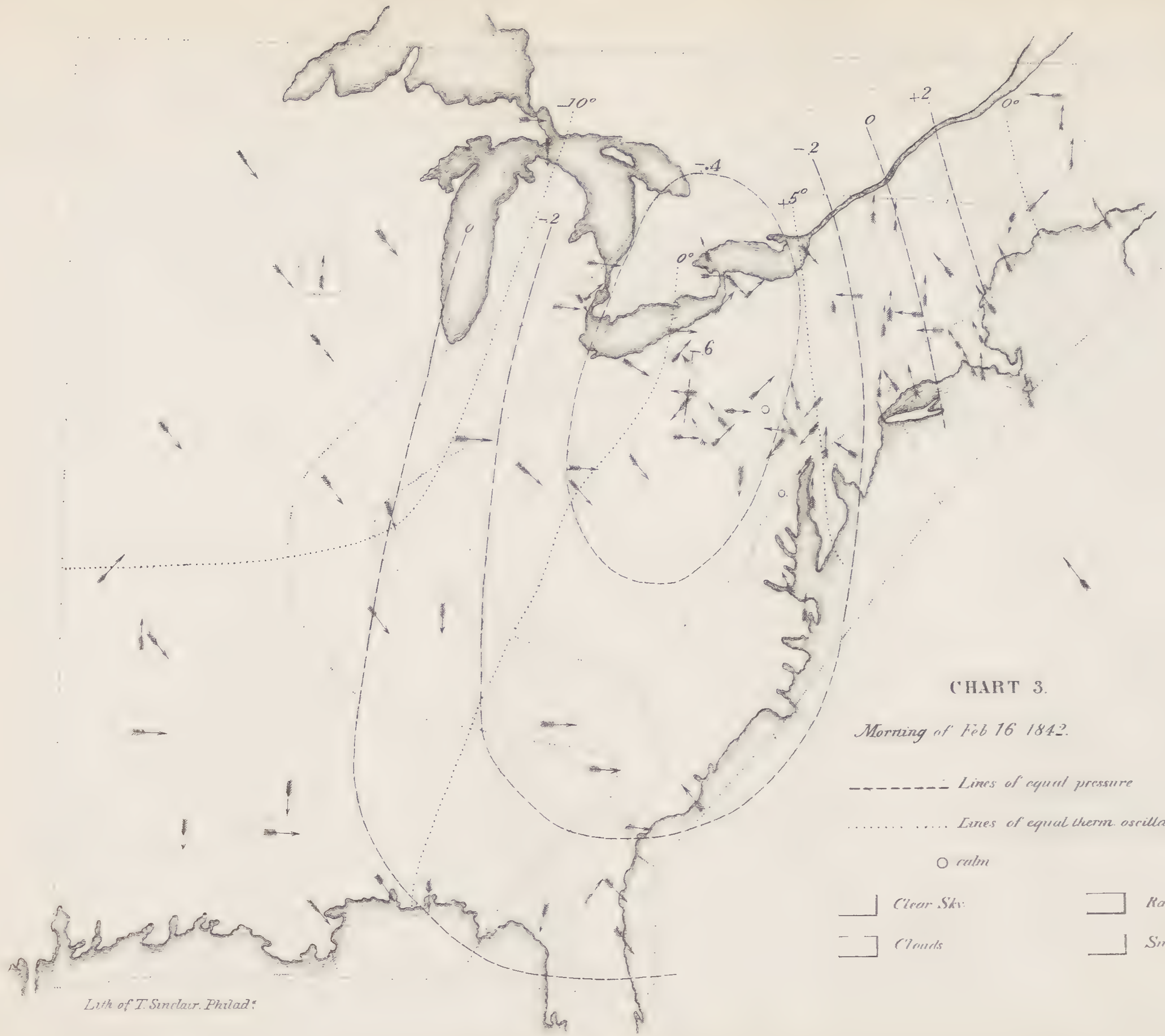


CHART 3.

Morning of Feb 16 1842.

——— *Lines of equal pressure*

..... *Lines of equal therm. oscillation*

○ *calm*

Clear Sky | *Rain*

Clouds | *Snow*

Lith of T. Sinclair. Philad.

PL XVI.

CHART 4.

Evening of Feb. 16. 1842.

——— *Lines of equal pressure*

..... *Lines of equal therm. oscillation*

○ *calm*

Clear Sky *Rain*

Clouds *Snow*

CHART 5

Morning of [illegible] *17, 1842.*

——— *Lines of equal pressure*

. . . . . *Lines of equal thermometric oscillation*

Other

Clear Sky — *Rain*

Clouds — *Snow*

CHART 6

Evening of Feb. 1. 1842.

———— *Lines of equal pressure*

..... *Lines of equal therm oscillation*

○ *calm*

Clear Sky

Clouds

CHART 7

Warning [illegible] 12 1512

[illegible]

[illegible]

[illegible]

Ocean Sky

Clouds

Rain

CHART 8

Evening at Sea 2 1842

Lines of equal pressure

Lines of equal thermometric altitude

Cirro

Cirro N.

Cirrus

Rain

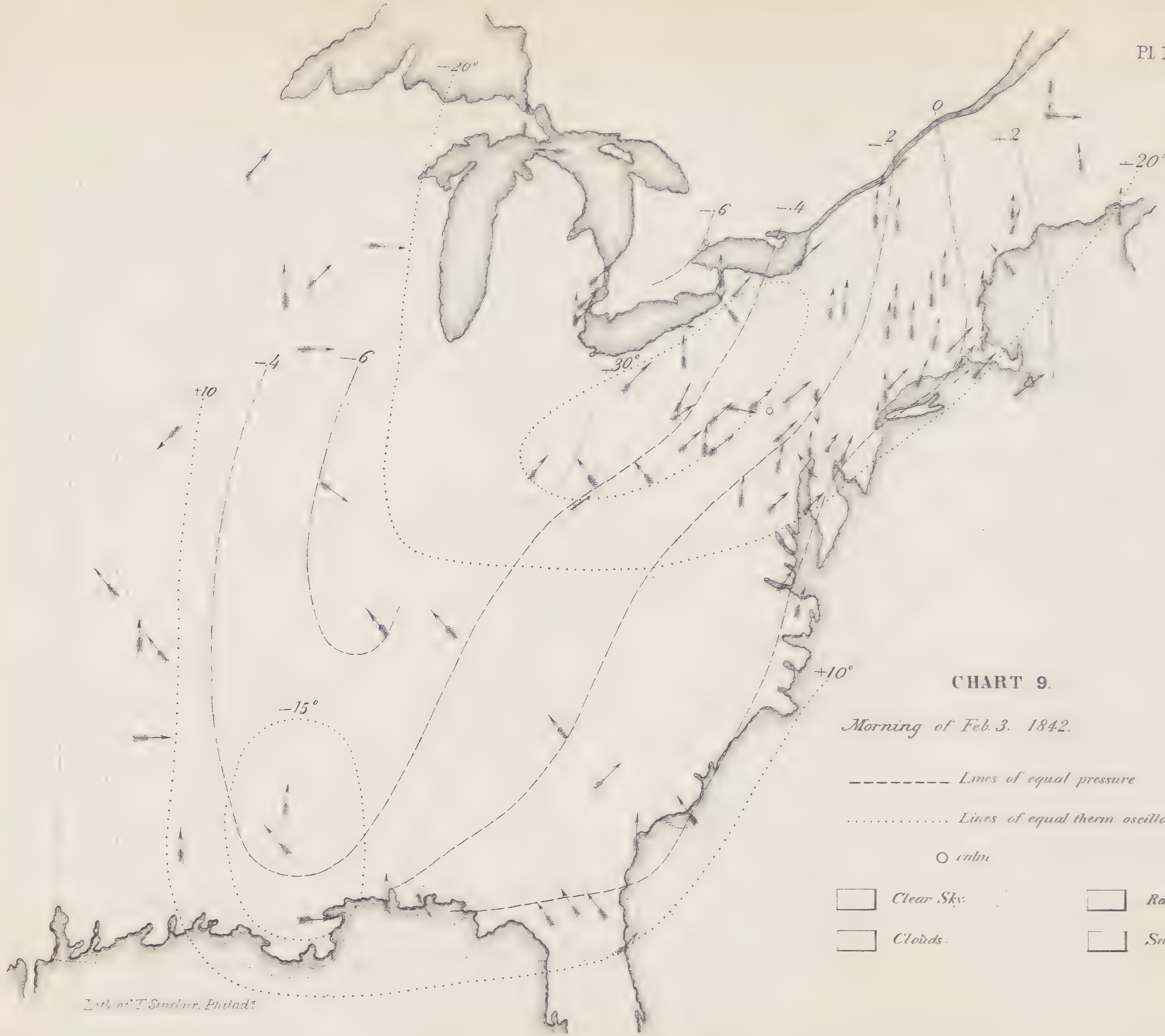


CHART 9.

Morning of Feb. 3. 1842.

——— *Lines of equal pressure*

..... *Lines of equal therm oscillation.*

○ *calm*

Clear Sky — *Rain*

Clouds — *Snow*

Lith. of T. Sinclair. Phila.ª

CHART 10.

Evening of Feb 3, 1842

——— *Lines of equal press.re*

. . . . . *Lines of equal therm. oscillation*

○ *calm*

Clear Sky *Rain*

Clouds *Snow*

Fog

CHART II.

January at Fet. 4. 1842.

Lines of equal pressure

Lines of equal therm. oscillation

calm

Clear Sky

Rain

Clouds

Snow

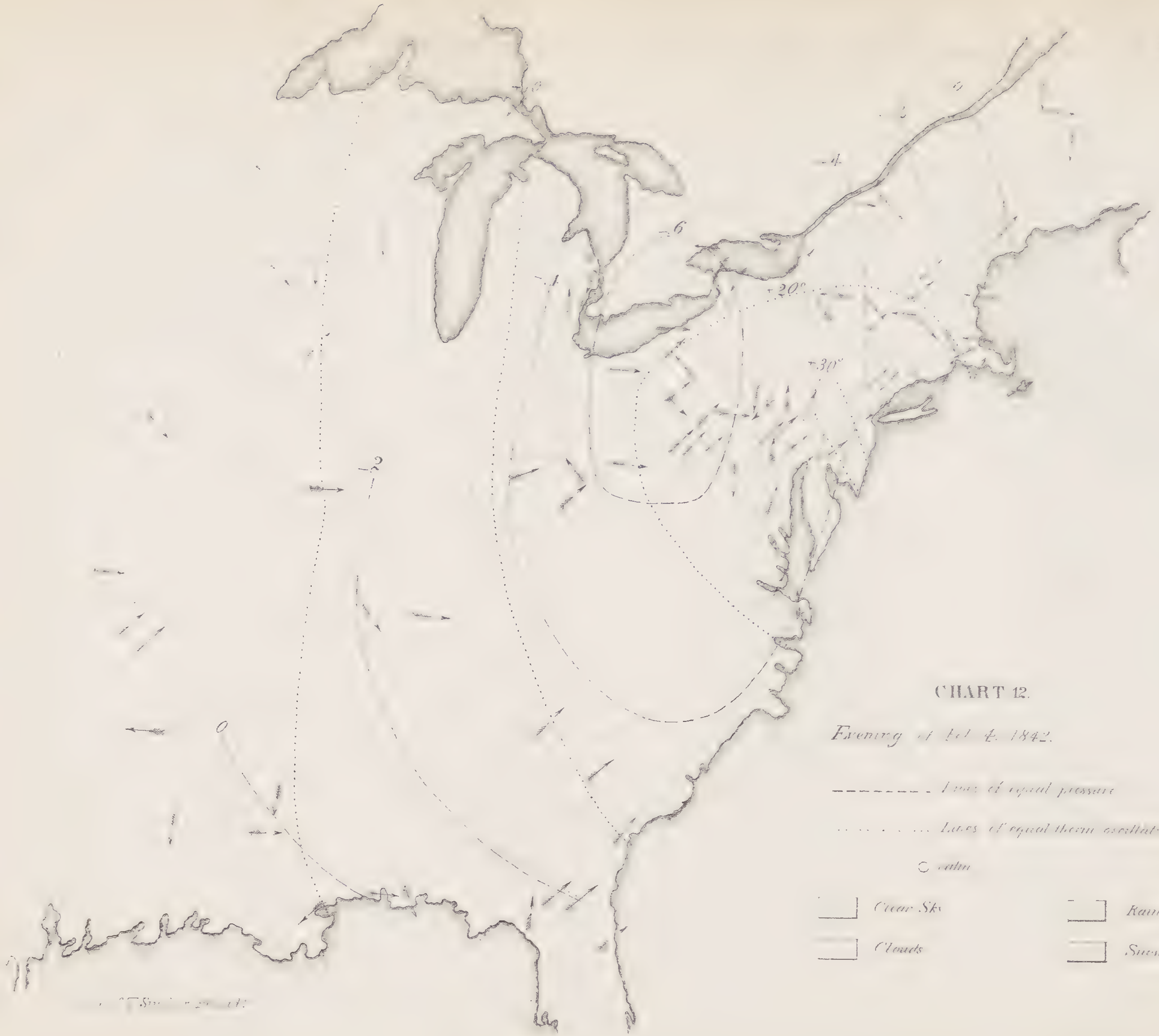


CHART 12.

Evening of Oct 4. 1842.

——— *Lines of equal pressure*

. . . . . *Lines of equal thermo oscillation*

○ *calm*

Clear Sky — *Rain*

Clouds — *Snow*

CHART 13.

Morning of Feb. 5 1842

——— *Lines of equal pressure*

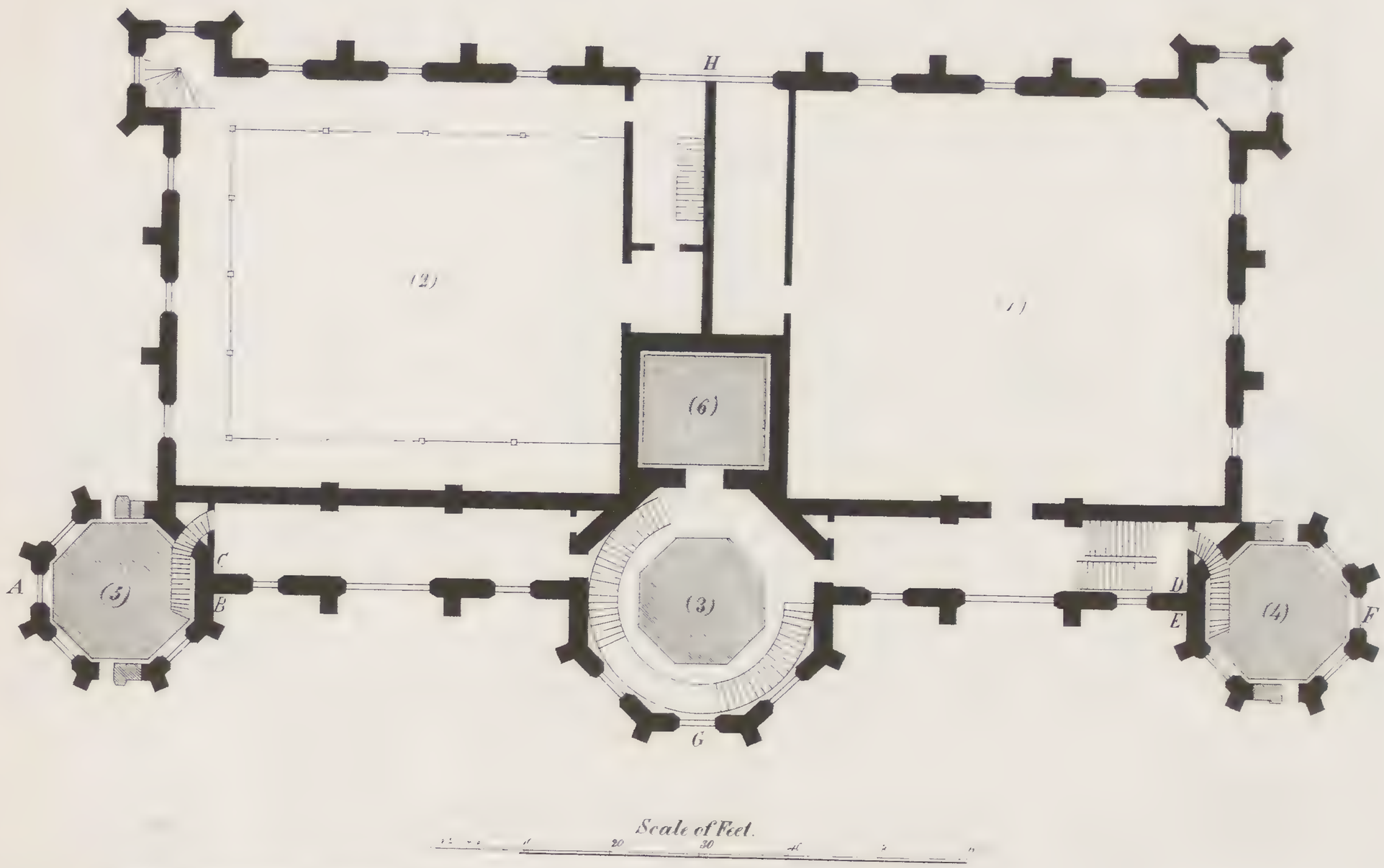
. . . . . *Lines of equal diurnal oscillation*

Calm

Clear Sky — *Rain*

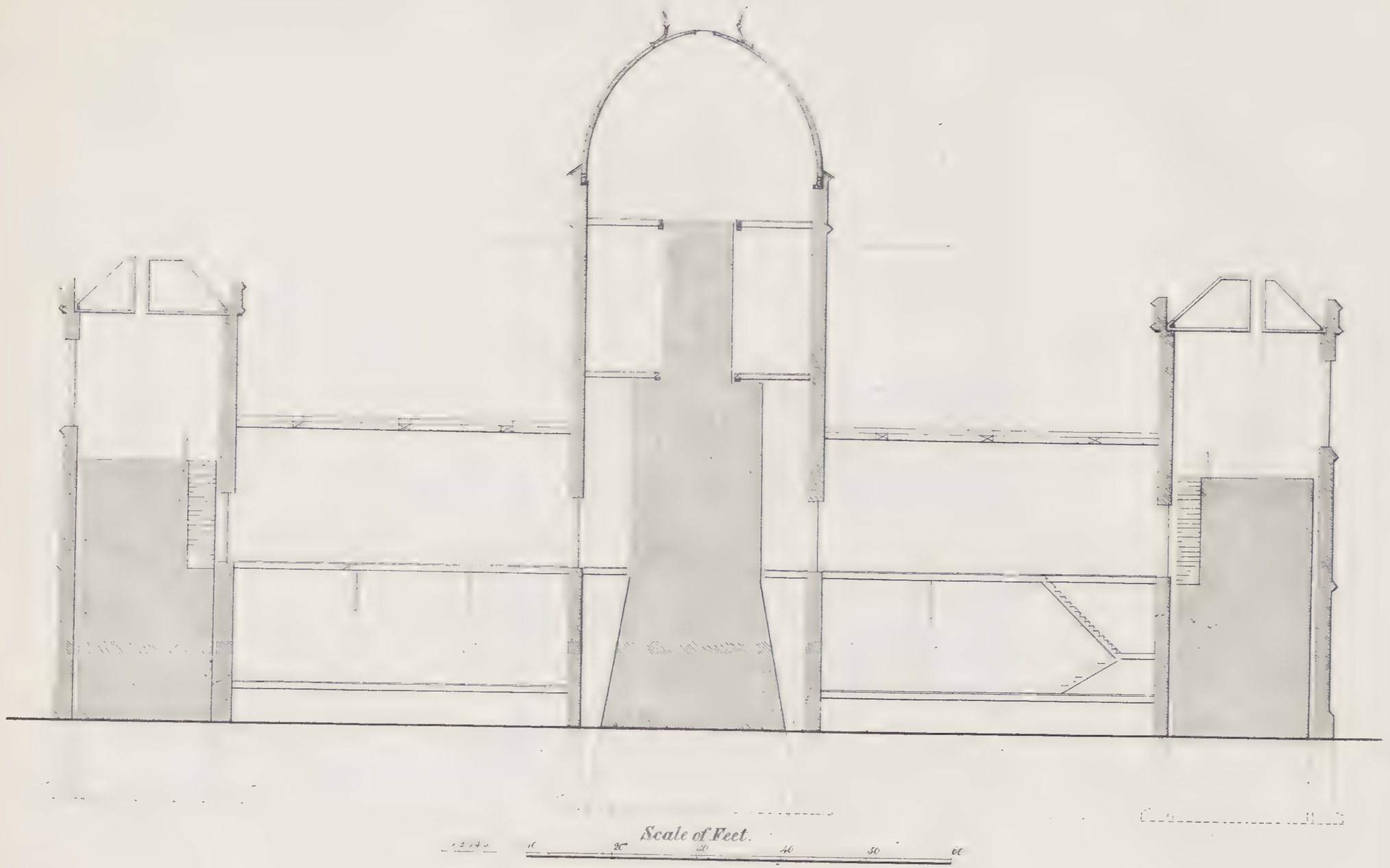
Clouds — *Snow*

Fig. P.



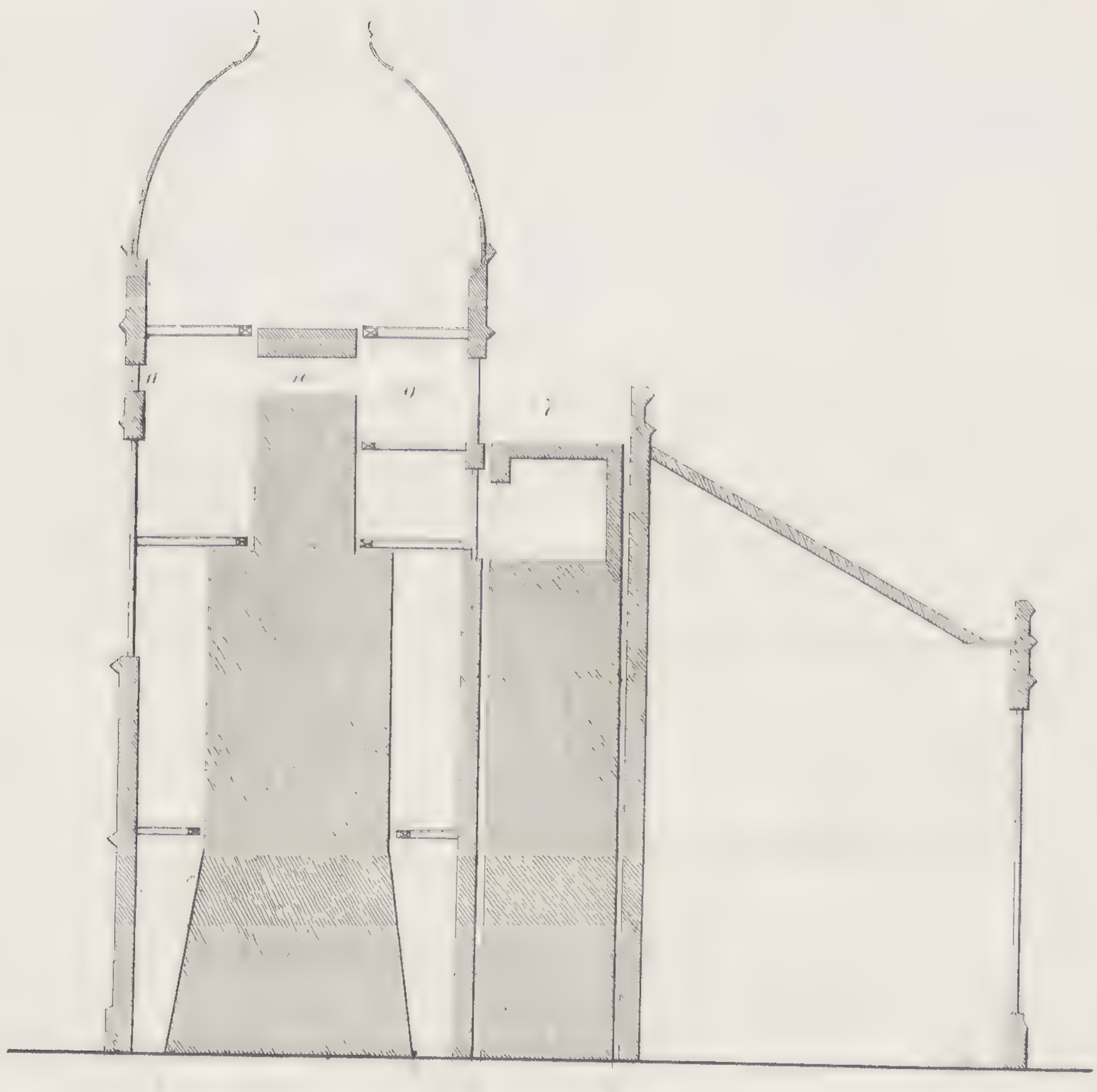
Ground plan of the building for the Literary & Philosophical Apparatus West Point

Fig. 6.



Section through the towers on the North front

Fig. R.



Scale of Feet.

Section through the middle tower, perpendicular to the North front.

Fig. 8.

West Point Equatorial
by Thomas Grubb of Dublin

Fig T.

Fig. D.

Fig C.

Fig E.

Floor

Meridian Section of the Equatorial.

ROUGH SKETCH OR RECONNOISSANCE OF THE COPPER REGION AND OF THE GEOLOGY OF THE SAVANA REGION OF CIBARA IN THE ISLAND OF CUBA

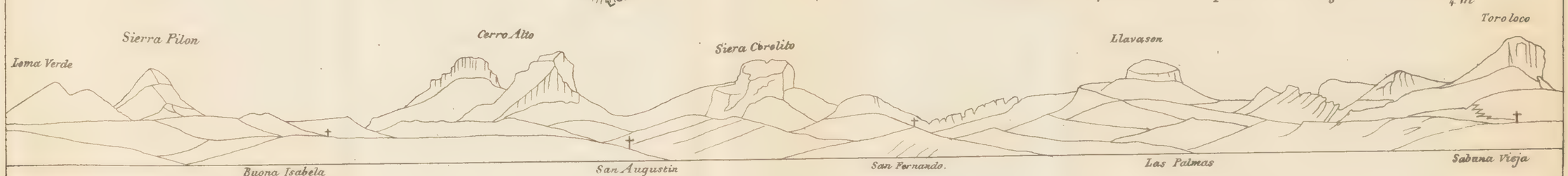
FROM THE FIELD NOTES OF RICHARD C. TAYLOR

The Coast Line is merely Sketched to shew its General form & bearing with reference to the interior.

GIBARA · Fort · The Point · THE REEF · The Bank · The ancient Reef 15 or 20 feet above High Water · BAHAMA CHANNEL · PUERTA DE JUJURA · BAY OF GIBARA · Low Swampy Flats · Path · Limestone · Road · Cocoyen · Red House · Swampy Flats · Dark altered Rocks · Candelaria R. or · Limestone · Gibara · Limestone · Serpentine & Diabase · Embareadero · Rio · PORTRERILLO · St Mary · Chapman · Magnesian Serpentine · CANDELARIA · Limestone · Altered Rocks · Limestone · Trap · Porphyry · Cross · Wm B. Lord · Trap · Road · FRAY BENITO · First Limestone Chain and Anticlinal Axis N. 60° E. · Serpentine · Limestone · Trap · Wood · Gibara ariba · Limestone · Trap · R. Llavason · Road · Trap · Greenstone · Dialage · Serpentine & Diallage · Limestone · Hall · Vila P. Hills · S.to Gibara · Copper · LA SILLA · EL PARAMO. · Road to Barrai · Limestone Ridge · Cao to de los Ranches · Copper · Llavason · Greenstone · Anticlinal Axis · Diabase · Copper · Magnesian Rocks · Limestone · Serpentines · Limestone bands · Euphotide · RABON · S.to Rabon · RANCHES · Limestone · Copper Lodes · General direction of the Central Euphotide · Magnesian Rocks · Limestone · S.to Puno · Ridges of the Islands of Cuba & Hayti N 10° W. · Sabana · Magnesian Rocks · Greenstone · Loma Large · CERRO COLORADO · LLAVASON · Hypersthene & Serpentine · Copper · From Holguin · COROLITO · Diallage · CERRO GIBARA · Diabase · Greenstone · Guarayahone · Third Limestone Chain · Metalloide Diallage Rocks · TORO LOCO · Serpentine · Trap · SIERRA COROLITO · Diabase · MELONES · CERRO ALTO · Los Tibis · Loma · San Fernando · Copper Lodes · Perseverancia · Copper · Chrome · Lomas · Prosperidad · San Augustin · Copper Lodes · Loma Larga de la Palma · SABANA VIEJA · Limestone Hills · Euphotide · From Holguin · Copper Lodes · SIERRA PILOT · Fourth Limestone Chain · LOMA VERDE · LAS PALMAS

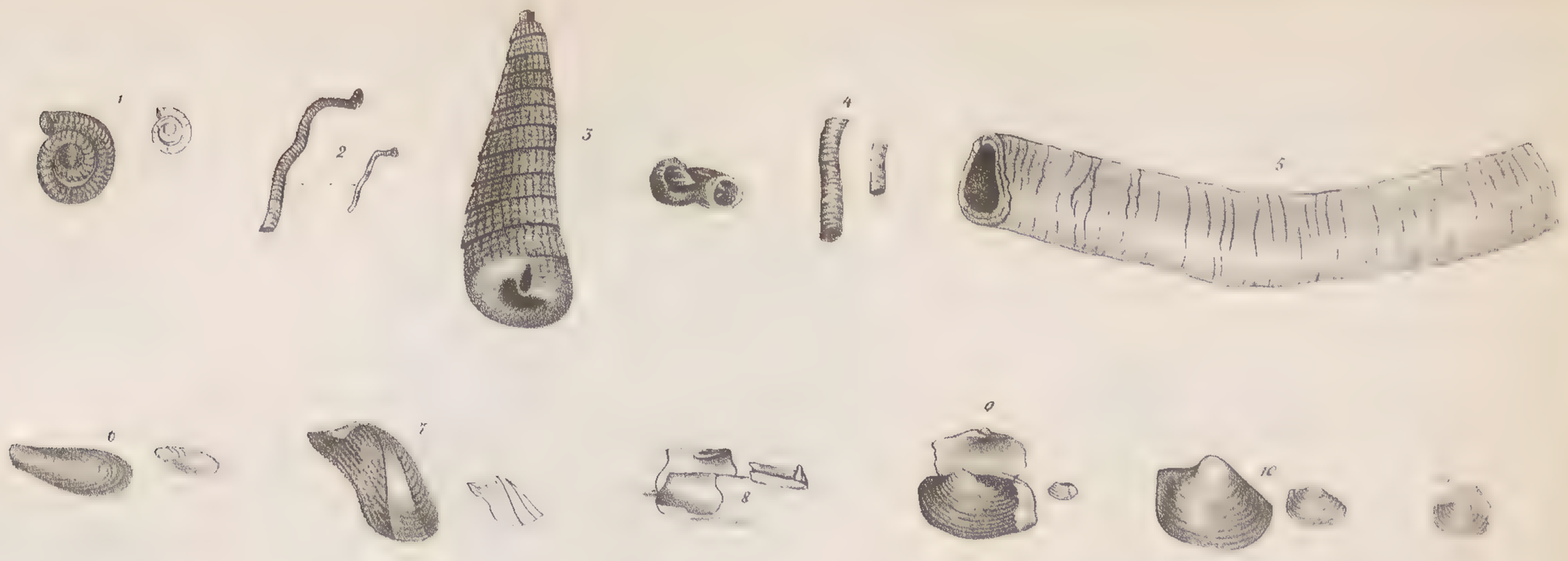
Scale One Inch to a Mile

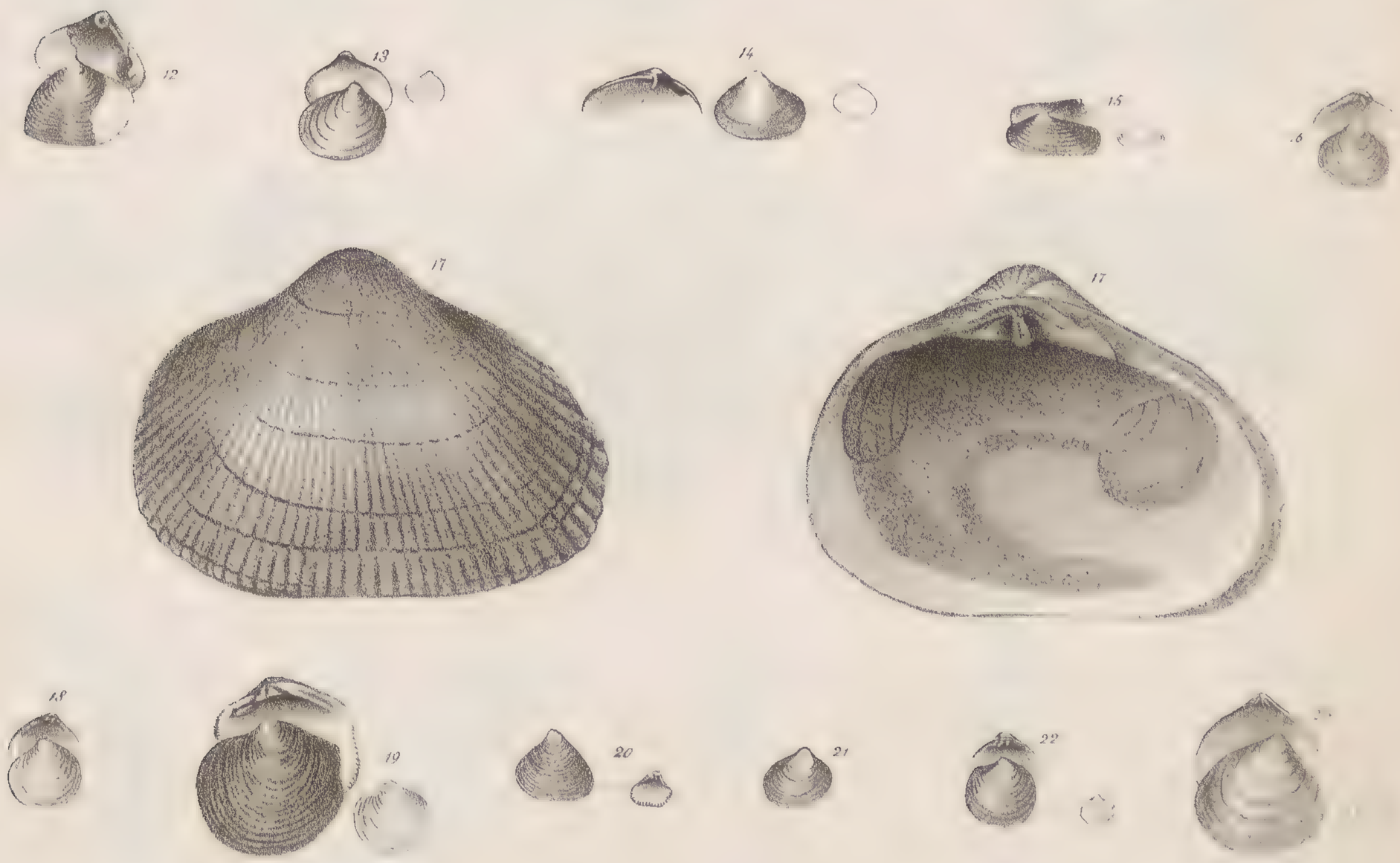
1 2 3 4 M



View of the Limestone Mountains in the Copper Region from Saban Vieja.

Lith of Sinclair 79 S Third St Ph.





1 *Serpula convoluta*
2 " *anguina*
3 *Petaloconchus sculpturatus*
4 *Teredo calamus*
5 " *Fistula*
6 *Gastrochæna ligula*
7 *Pholas rhomboidea*
8 *Solen magnodentatus*
9 *Panopæa dubia*
10 *Mya reflexa*
11 *Thracia transversa*
12 *Anatina tellinoides*
13 *Aligena striata*
14 " *lævis*
15 *Petricola compressa*
16 *Psammocola lucinoides*
17 " *regia*
18 *Lucina punctulata*
19 " *lens*
20 *Astarte lineolata*
21 *Cytherea elevata*
22 " *sphærica*
23 *Venus ascia*
24 *Eratella lancea*
25 *Nucula dolabella*
26 " *diaphana*
27 " *aquilatera*
28 " *cancellata*
29 *acutidens*

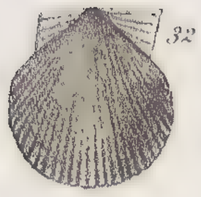
H.C. Lea. del

T. Sinclair's Lith. Phila.

Trans. Am. Phil. Soc. 2d Series Vol 9 : Pl 35.

30

31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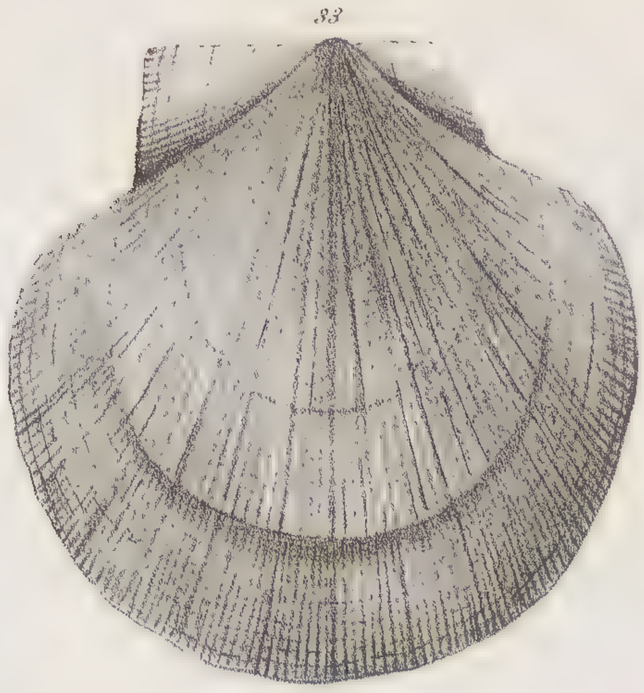
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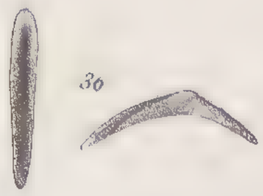
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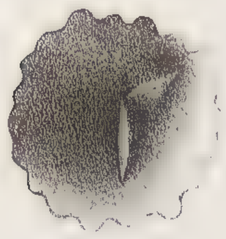

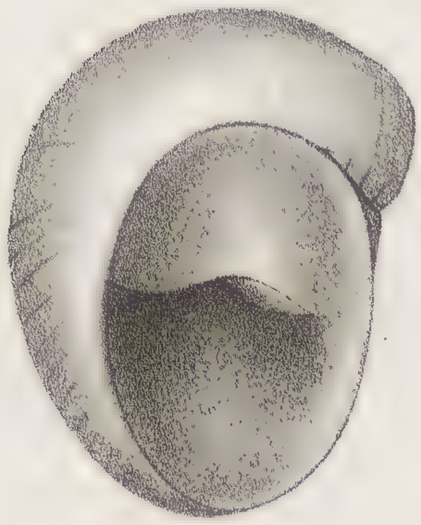
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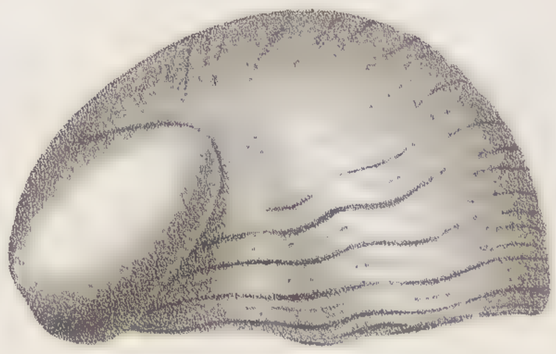
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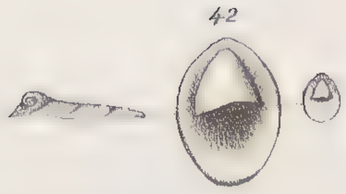
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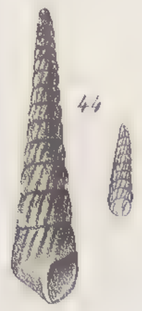
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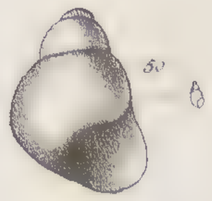

50

30. *Modiola spinigera*
31 *Avicula multangula*
32 *Pecten triscopleura*
33 „ *tenuis*
34 *Plicatula rudis*
35 *Chiton transenna*
36 *Patella acinaces*

37 *Cemoria oblonga*
38 *Calyptraea pileolus*
39 *Infundibulum concentricum*
40 *Crepidula ponderosa*
41 „ *cornucopiæ*
42 „ *lamina*
43 *Bulla cylindrus*

44 *Pasithea exarata*
45 „ *subula*
46 „ *eburnea*
47 „ *lævigata*
48 „ *ovulum*
49 „ *diaphana*
50 „ *turbinopsis*

H. C. Lea del.

T. Sinclair's Lith. Phila.

51 *Natica apertus.*
52 „ *sphærulus*
53 „ *crassilabrum*
54 *Actæon granulatus*
55 „ *globosus*
56 „ *turbinatus*
57 „ *angulatus*
58 „ *glans*
59 „ *sculptus*
60 „ *nitens*

61 *Actæon milium*
62 „ *simplex*
63 *Pyramidella suturalis*
64 „ *elaborata*
65 *Scalaria acicula*
66 *corrugata*
67 *micropleura*
68 *mucrostoma*
69 *Delphinula costulata*
70 „ *concava*

71 *Delphinula lipara*
72 „ *oblique-striata*
73 „ *trochiformis*
74 „ *globulus*
75 „ *aperta*
76 „ *naticoides*
77 *Rotella subconica*
78 „ *carinata*
79 „ *lenticularis*
80 „ *umbilicata*

H. C. Lea, del.

T. Sinclair's Lith. Philad.

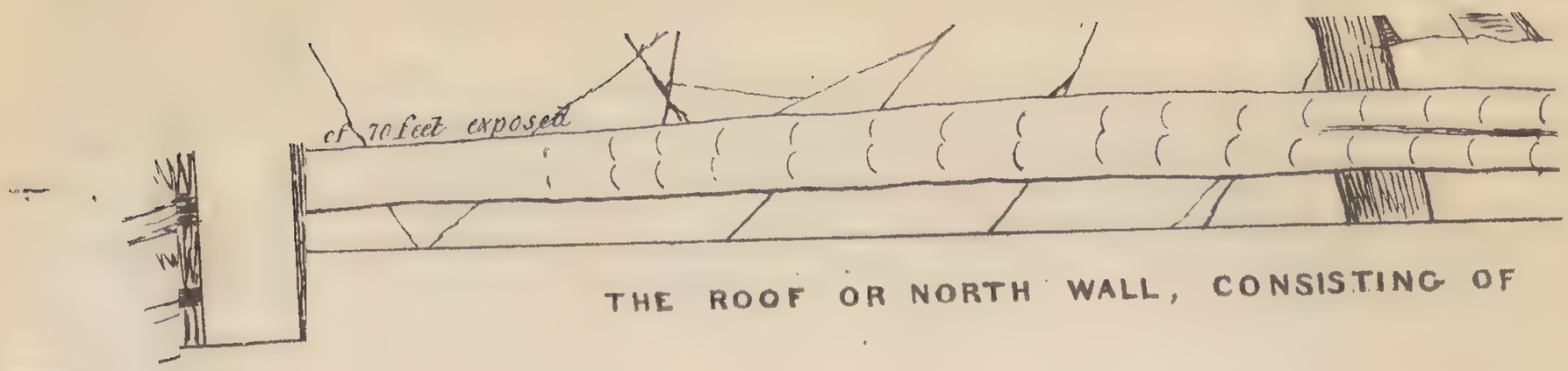
81 *Trochus armillus*
82 „ *conus*
83 „ *lens*
84 „ *torquatus*
85 „ *aratus*
86 „ *Ruffinu*
87 *Turbo glaber*
88 „ *rusticus*

89 *Cerithium clavulus*
90 „ *curtum*
91 „ *Dædaleum*
92 „ *moniliferum*
93 *Pleurotoma lunatum*
94 *Fasciolaria parvula*
95 *Fusus pygmæus*
96 „ *anomalus*
97 *Buccinum Tuomeyi*

98 *Buccinum pusillum*
99 „ *frumentum*
100 „ *quadrulatum*
101 *Nassa impressa*
102 *Marginella conulus*
103 „ *cardis*
104 *Oliva canaliculata*
105 „ *ancillariæformis*

H. C. Lea del

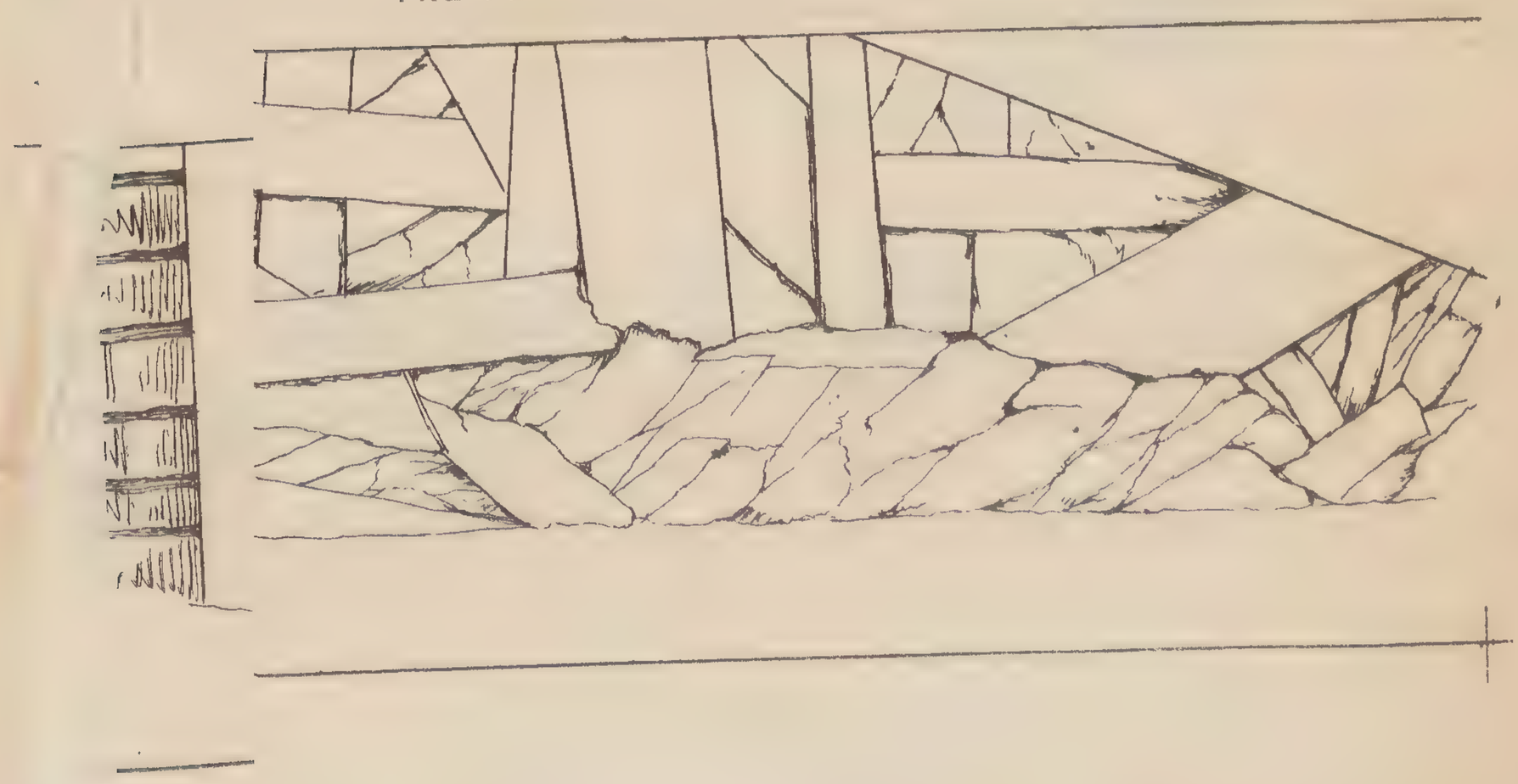
T. Sinclair's Lith Philad.



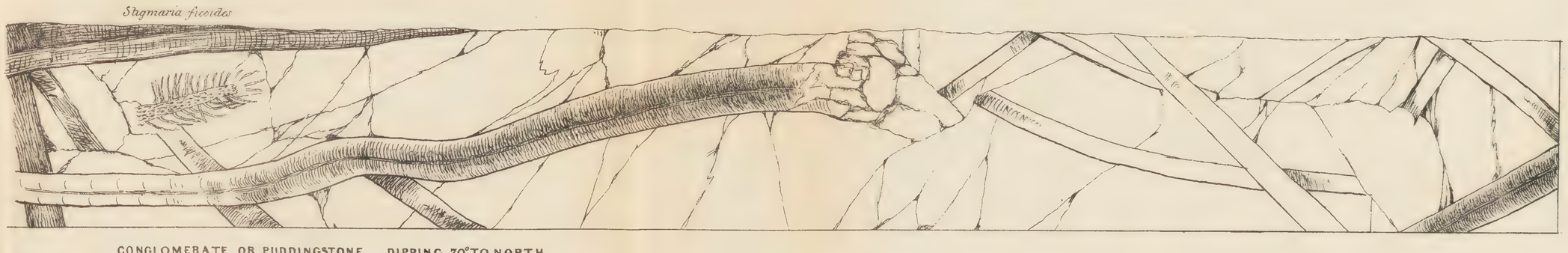
THE ROOF OR NORTH WALL, CONSISTING OF

ral Slate.

THE FLOOR OR SOUTH WALL OF CLAY SLATE AND FIRE



FLOOR OF THE PERSEVERANCE COAL SEAM, IN DAUPHIN CO. PENN^A.



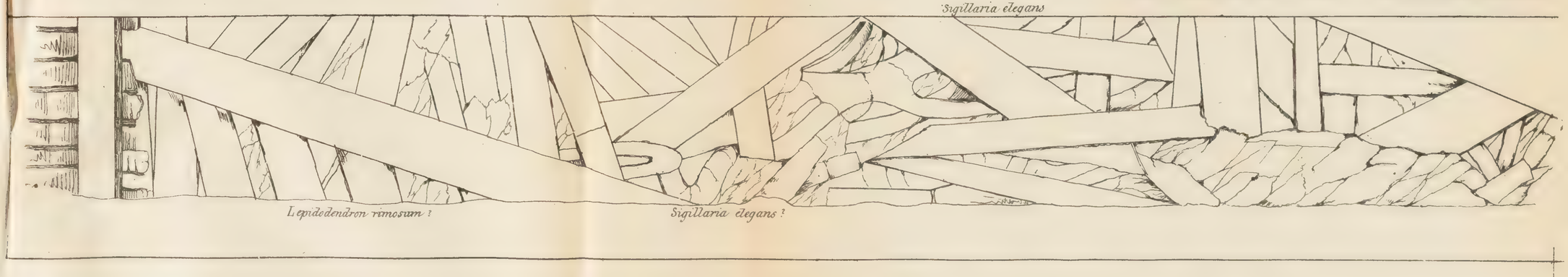
To illustrate M^r R.C Taylors Paper in the Trans Phil Soc. of Am.

FOSSIL SIGILLARIA AND OTHER COAL PLANTS IN THE ROOF AND

THE ROOF OR NORTH WALL, CONSISTING OF

GALLERY OR GANGWAY *between the Walls of the Vein.. Nine feet wide.. Course varies from N 64½ to 71° E. having about 3 Feet of Central Slate.*

THE FLOOR OR SOUTH WALL OF CLAY SLATE AND FIRE



A PLAN OF THE PRINCIPAL TRIANGLES IN THE TRIGONOMETRICAL SURVEY OF MASSACHUSETTS.

Explanation.

Primitive Stations (except in the State Line) are marked with a triangle, thus △

Secondary Stations, with a circle, ... ○

and, if Churches, a cross is added ⛪

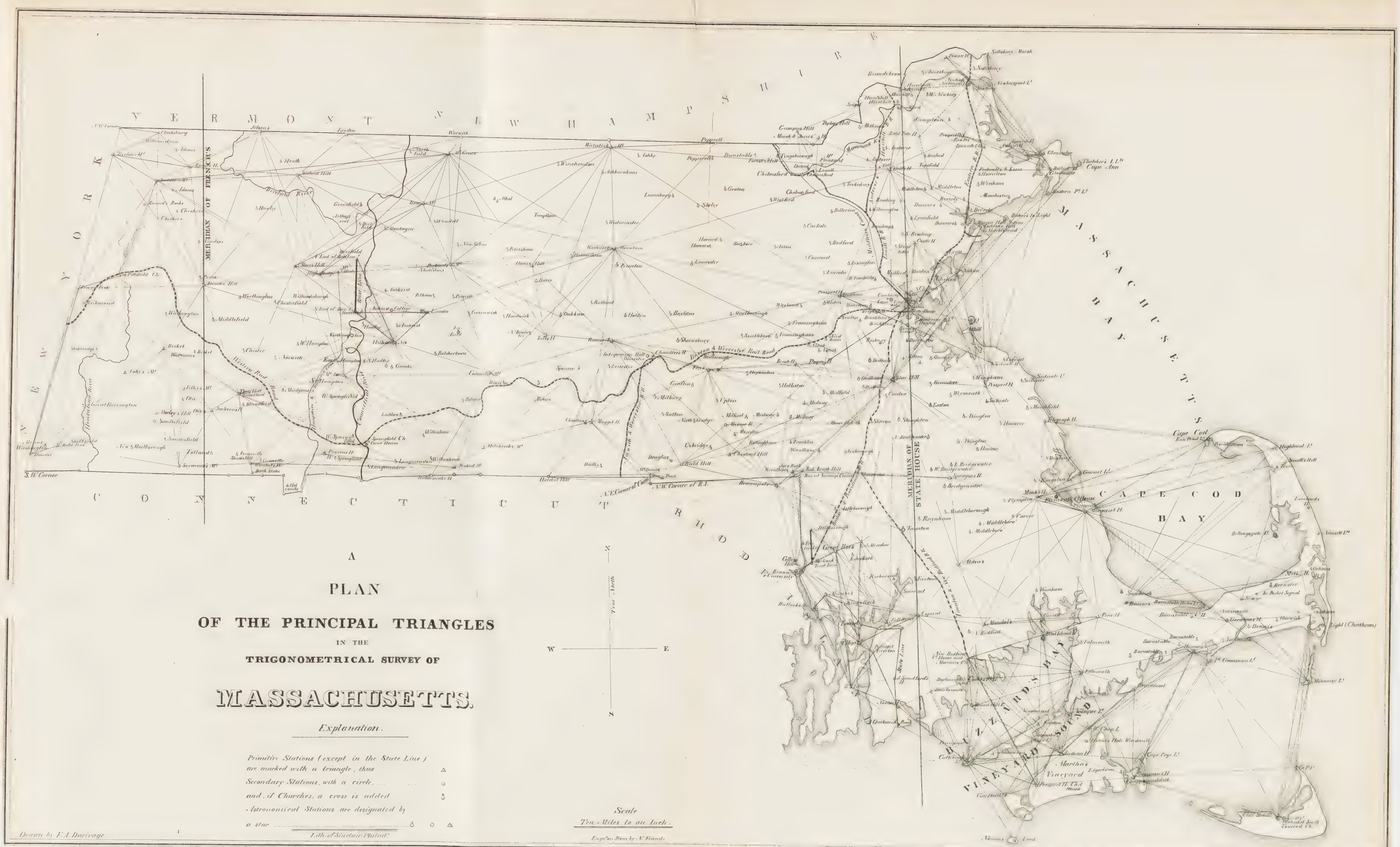
Astronomical Stations are designated by a star ..... ☼

Drawn by F. A. Durivage.

Lith. of Sinclair Philad.

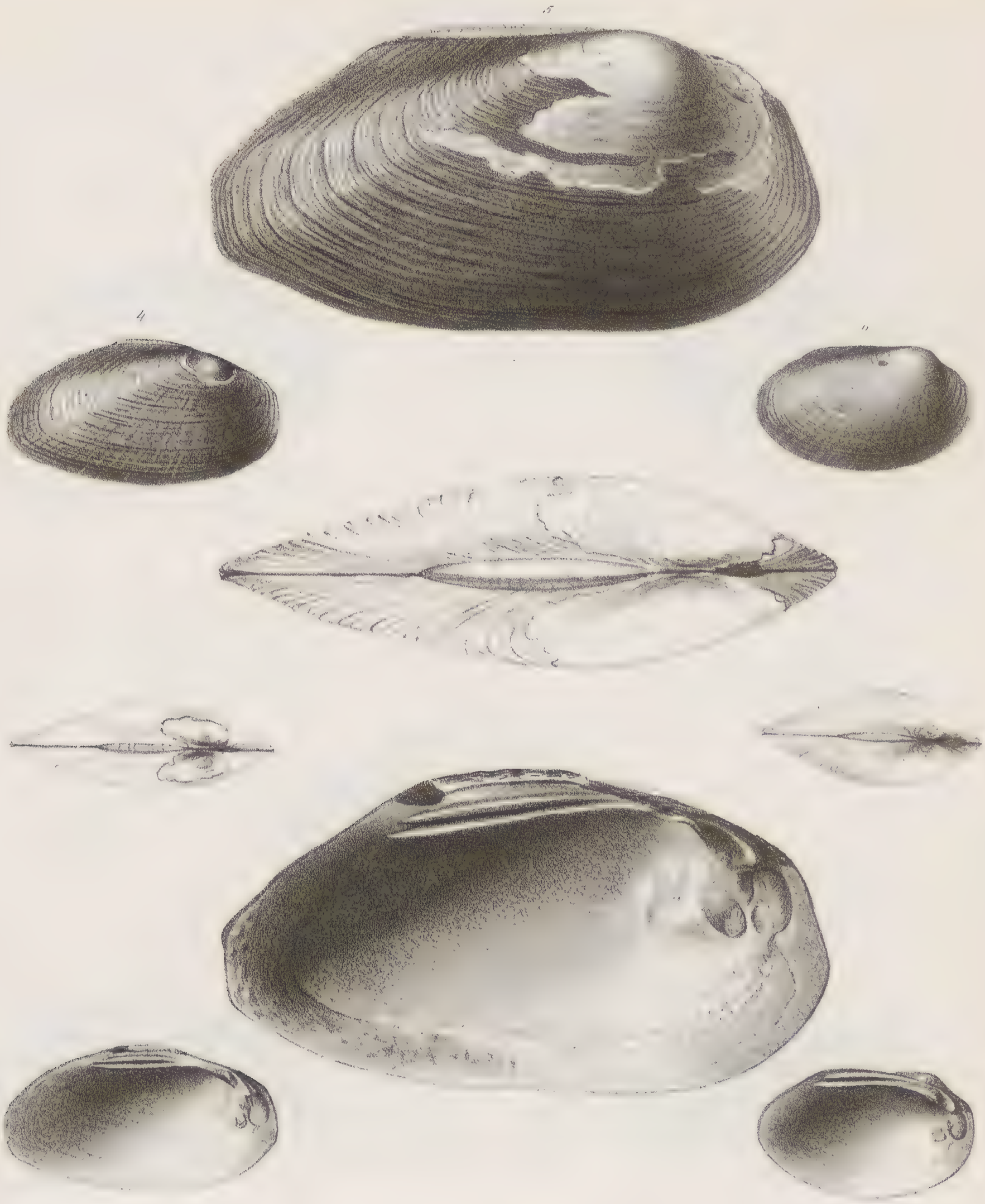
Scale Ten Miles to an Inch.

Engr.ed on Stone by W. Friend.



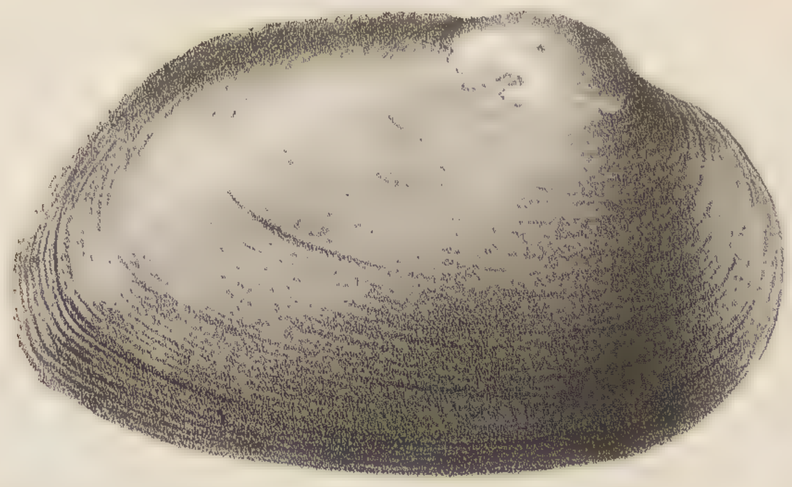
1. *Unio amygdalum*
2. *Unio Buckleii*
3. *Unio minor.*

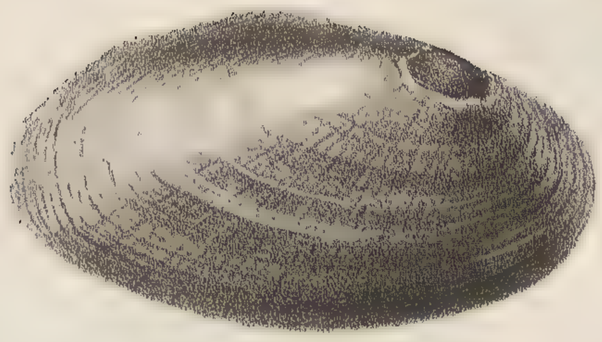
Lith. v. Natterer, Kon. Steind. in München

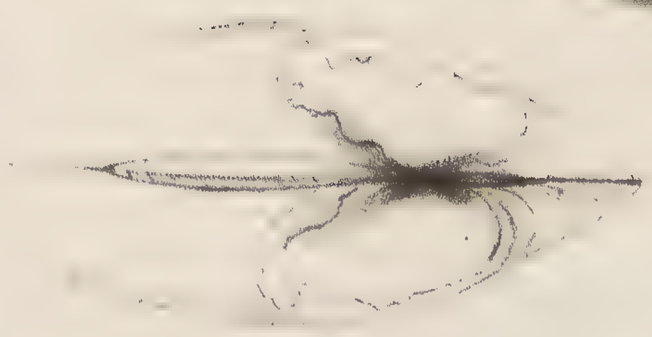


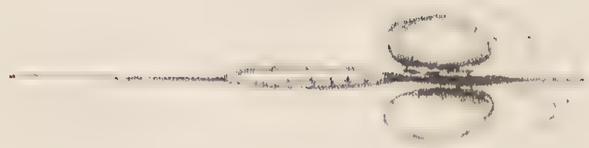
4. Unio fuscatus.
5. Unio Buddianus.
6. Unio trossulus.

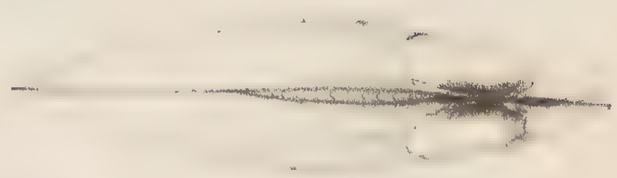
8

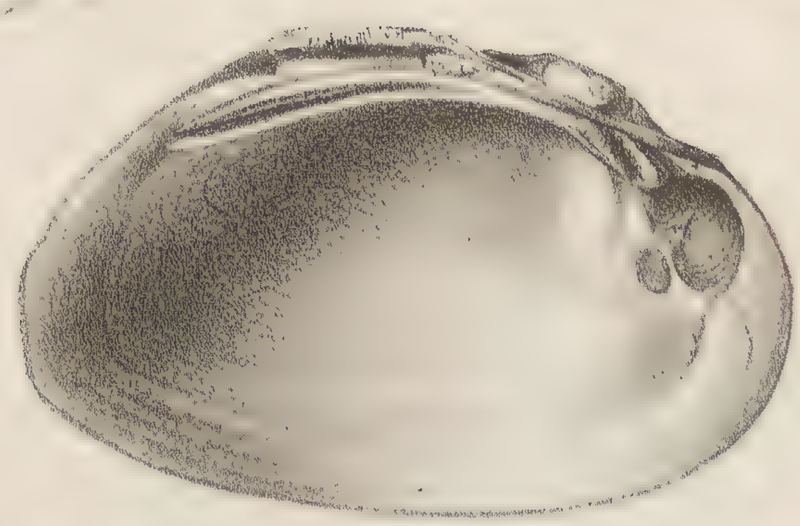


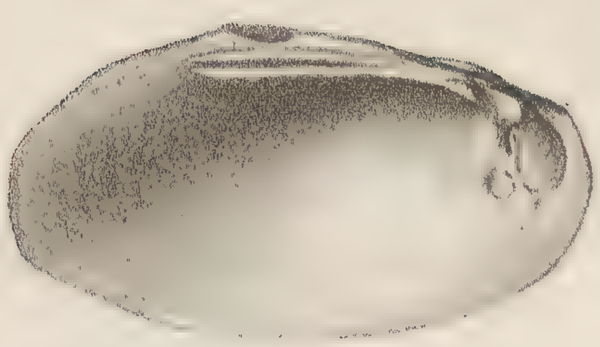


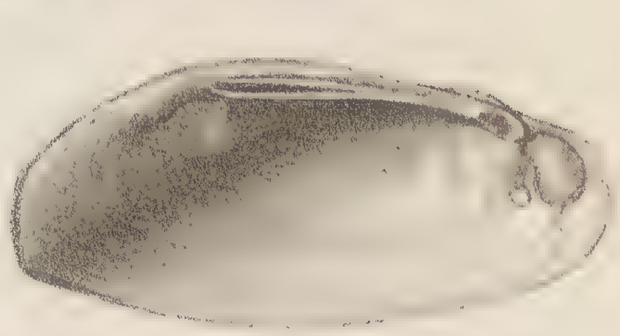












Unio ovalis
8 *Unio Monroensis.*
9 *Unio aheneus*

* Nature & on Stone by

Sinclairs Lith. Phil.

10

11

12

10. *Unio neglectus*
11. *Unio superbus*
12. *Unio ornatus*

MAGNETIC CHART OF THE UNITED STATES

By JOHN LOCKE.

100 95 90 85 80 75 70

50 45 40 35 30 25

S. 1830 & L. 1904.

Isothermic lines

S. 1808.7 L. 1904.

Isoclinal lines

S. 1820.5 L. 1904.

Sabine 1809.4. Locke 1904.

Col Sabine's line of 1700. Projected as an approximation from observations made on the extreme limits of the continent.

S. 1693.1 L. 1904.

Axis of greatest Westerly Variation

Sabine 1818. Locke 1904.

Locke 1850.

Line of no variation

Dip

PART OF COL. SABINE'S NORTH POLAR CHART,

Exhibiting the Observations of Magnetic Intensity.

Trans. Am. Phil. Soc. 2d Series Vol 9 Pl. 11.

PORTERS ISLAND

White Pine trees
Rock
Gravel bank thrown over by the Lake
Gen.l Cunningham U.S Agency
Metamorphic Sand stone, amygdaloid Trap
Sand, gravel, & soil, with small trees
Bare conglomerate rock
Small Fir Trees, thin soil, and solid rocks beneath
Locke's Encampment
Magnetic
Conglomerate Rocks
Scale of Feet
0 50 100 200 300 400 500 600 700

a b c Sectional section of Porters I. in the line ab.
a to c Metamorphic Sandstone.
a to b. conglomerate with transverse vertical veins of Side Spar and COPPER ORE.

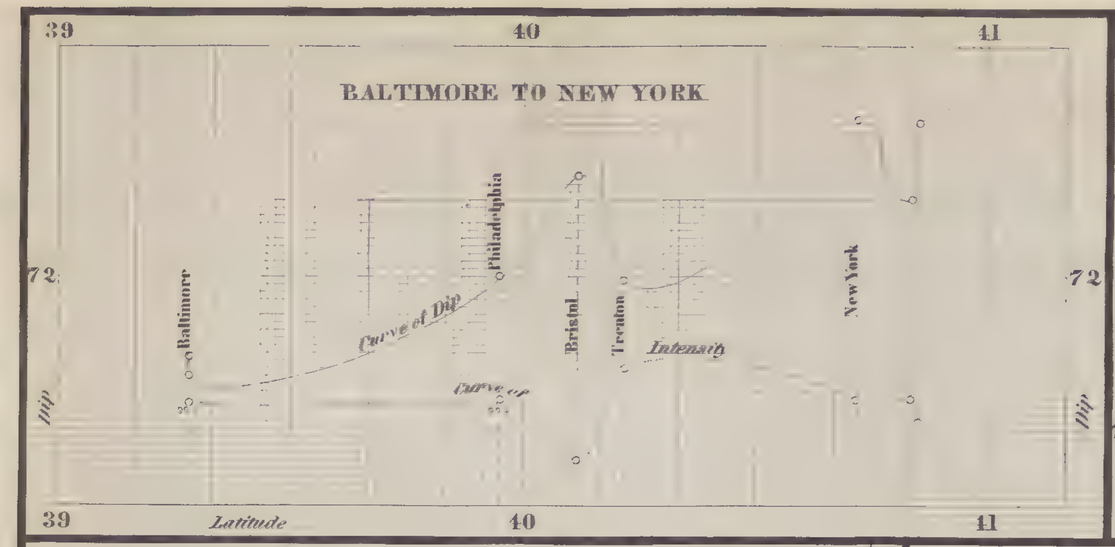
LAKE SUPERIOR

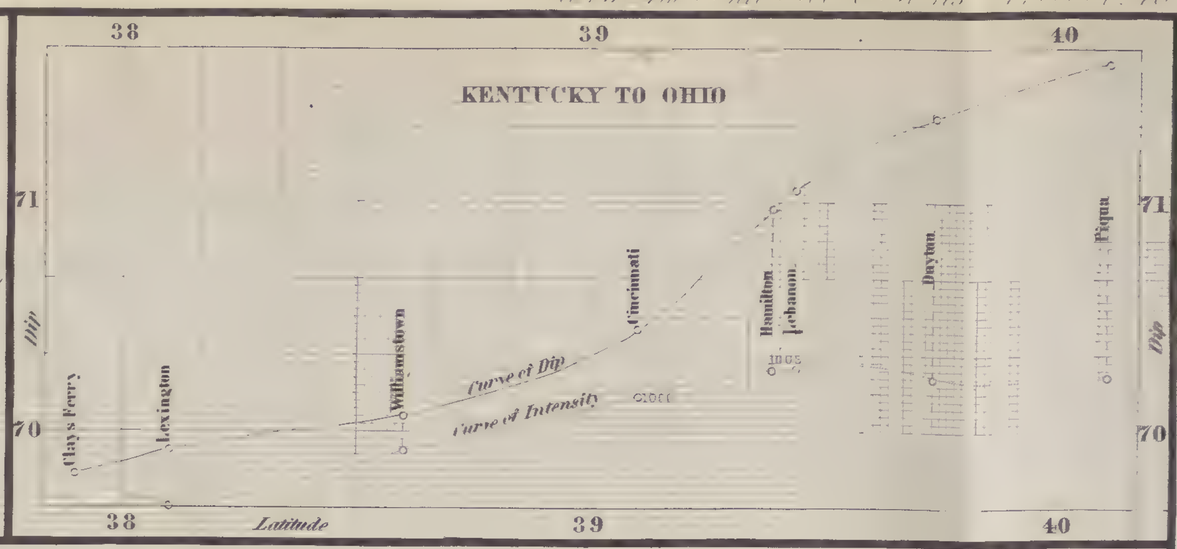
Long. 88° 05' W.
Porters I.
Metallic Copper
Lat. 47° 29' N.
Green Rock Copper Mine
White Rock
COPPER HARBOR
ONE MILE
HOUGHTONS LAKE

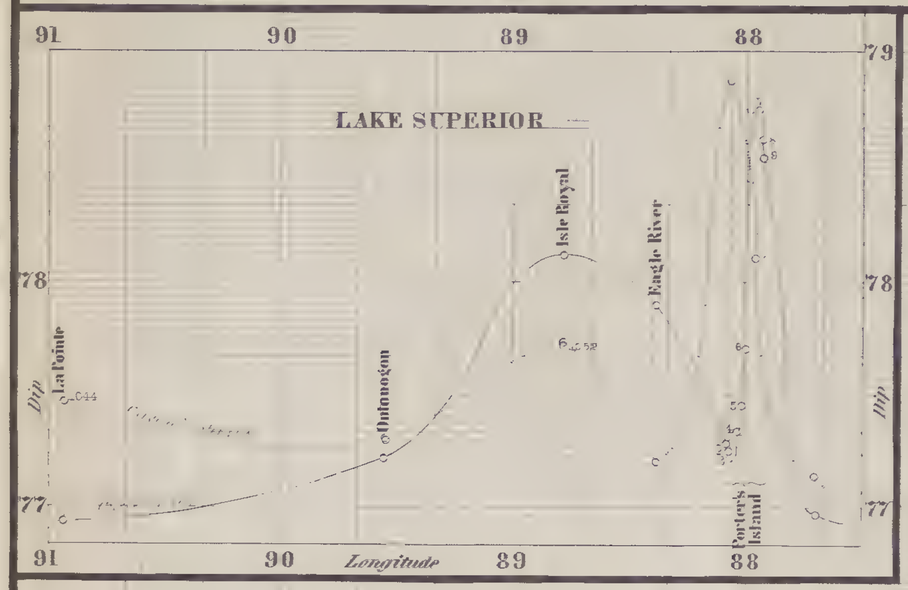
Conglomerate
White Side Spar
Green Carbonate of Copper
White Side Spar
Conglomerate
GREEN ROCK COPPER VEIN.

GEOLOGICAL & MAGNETICAL
CHART OF
COPPER HARBOR.
BY
John Locke.

CURVES showing the DIP & INTENSITY by means of ORDINATES.







283

Date Due

29 Dec 50

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